MINERS' NYSTAGMUS.

T H E S I S

SUBMITTED FOR THE

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by

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INTRODUCTION.

The oscillation of the eyeball which prevents the coal miner from accurately fixing an object towards which his vision is directed is known as Miners' Nystagmus.

It is an occupational disease confined entirely to miners in the coal fields; miners who work in open mines, to which daylight penetrates, do not contract the disease. Neither is the disease found in workers of ironstone mines, except in those with coal seams, which necessitates the use of safety lamps. In zinc mines, Stassen has found nystagmus causing no incapacity.

The prevalence of the disease also varies geographically, for it is common in this country, France and Germany, whereas in America and Japan the disease is rare.

This incidence also varies in different coal mines according to the type of lighting used. In flare and torch light pits the disease is unknown; in candle light pits the disease is rare and gives no incapacity, whereas in safety lamp pits the disease is rife.

Since first described by Deconde in 1861, it was recognised as far back as 1854 by Dr. Gillet of Sheffield, the etiology has not been definitely settled up to the present time, and many theories have been advanced to explain the causation/

causation. The views of Snell and his supporters, attributing the disease to the constrained position of the miner while at work held their ground up to the year 1910, when deficient light, held to be the causal agent, came into favour. It was thought that with more efficient lighting, the incidence of the disease would largely disappear. The introduction of electric lighting into the mines in 1914 was a great step forward, but this was not followed by any diminution in the incidence of the disease. This led to the revival of the theory, first enunciated by Pechdo in 1893, that the disease was due to intoxication of mine gases, by Dr. Robson of Penarth in 1923.

Further attention was drawn to the condition owing to the fact that the disease has been by legislation made a compensatable one. Though the condition was described and recognised some sixty-seven years ago, a miner so affected had no grounds for any claim for compensation or damages either at common law or under any statute until the Secretary of State ordered the disease to be included in the list of Industrial Diseases under the Workmen's Compensation Act in February 1907. The disease was then added to the Third Schedule of the Workmen's Compensation Act 1906 under the following designation:

Description of disease or injury.	Description of Process.
Nystagmus	Mining

Again, further attention was drawn to the disease on July 30th, 1913, when the definition of the disease was altered by order of the Secretary of State from the original "Description, Nystagmus. Process, Mining," to "the disease known as Miners' Nystagmus/

Nystagmus, whether occurring in miners or others, and whether the symptom of oscillation of the eyeballs be present or not."

Since 1906, the number of cases receiving compensation has been steadily increasing, a natural consequence of scheduling of any industrial disease, but in 1913, when the designation of the disease was altered to admit cases of psychophatic symptoms, there was a big jump, and, with the exception of the war years, the disease has been steadily increasing year by year. Prior to 1906, we have no accurate information of the prevalence of the disease, but examination of the underground workers brought out the fact that the disease is of considerable frequency. Some investigators have estimated that from 5 to 30% (even 50% by some) of all underground workers in coal mines are nystagmic. Here clearly is evidence of a pool, from which cases may arise. It is true that the great majority of these miners are unaware of the oscillation of their eyeballs, and have no disability, and in general it may be said that only about 0.2% are incapacitated in this country.

The economic loss on account of the incapacity nystagmus entails is great, and it falls on the workmen and employers as well as on the state. The amount of compensation paid for all industrial diseases in the mining industry has risen from £23,382 in 1908 to £343,094 in 1920. This increase has been said to be due entirely to nystagmus. In the last few years, the figure has increased to at least £500,000 per annum. This is a serious state of affairs for all parties concerned.

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The workman from his position of affluence and activity has descended to one of suffering and dependence on compensation.

The employer pays £500,000 a year in compensation, loses his best workmen and finds his output reduced.

The State loses the output of these skilled men and the shortage of coal will naturally reflect on other industries.

As the condition is of great interest, etiology still obscure, and the treatment both prophylactic and curative of great importance, I have thought that the subject is suitable for a thesis, having been in a colliery district for some years and had the opportunity of observing and treating a good number of cases.

In this thesis, I purpose to discuss the recent developments in connection with this disease, basing the work on my experience in a series of cases.

HISTORICAL ACCOUNT of the DISEASE.

The introduction of the Davey Safety Lamp into the coal-mining industry generally in the year 1850, was followed by the publication of the first recorded cases of Miners' Nystagmus in 1861 by Deconde. Dealing with the condition generally, in a paper published in the Archives of Belgium Academy of Medicine, he described two cases occurring in coal-miners, and ascribed to their production the etiological factors of anaemia and alcoholic excess. Still earlier knowledge of the malady was proclaimed by Snell for one Dr. Gillett, of Sheffield. In his book (1892) Snell claimed that Dr. Gillett was quite conversant with and recognised the condition as far back as 1854. Nieden in his Der Nystagmus der Bergleute (1894) claimed that Peppmuller described cases in the period of 1860 - 1863.

In 1875, C. Bell Taylor published in the LANCET a paper entitled, "Miners' Nystagmus, a New Disease." Considering the disease to be analogous to Writers' Cramp, he thought the condition due to overburdening of the eye muscles and the sustained efforts to see in a deficient light. Later in 1887, in the B. M. J. he says, "There is no central lesion, the affection is a pure myopathy."

During the seventies, the views as to the etiology of the condition/

condition began to diverge. Dr. Simeon Snell of Sheffield, the first and foremost in this country to investigate and treat the subject in a systematic manner, called attention in 1875 to the position assumed by the "holer" at work, i.e., constrained position with the visual regard directed obliquely upwards, and laid stress on its importance as an etiological factor in the production of the disease. This view was generally quoted in text books, and as an explanation of the condition of the phenomenon was considered adequate. The publications of Snell, from 1875 onwards, have led to a greater and more general knowledge of the disease, and they have been instrumental in promoting and stimulating investigations in this country as well as on the continent. During these earlier years the subject has interested various investigators on the continent, and amongst the most notable of these are Dransart (France), Nieden (Germany) and Romiee (Belgium).

Dransart in 1887 (Annales d'Occulist) published his first paper, in which he stated that nystagmus is due to a myopathy of the elevator muscles of the eye, and quotes Arlt (1867) who contended that the movement of the eyes in nystagmus is an attempt to bring a fresh part of the retina to bear on the same point in the interest of vision. Later in the year 1891, in a letter to the B. M. J., he expresses agreement with Snell as to the influence of position "as the first prime cause in the production of the disease."

Nieden, whose book "Der Nystagmus der Bergleute" is the standard in Germany, found the disease in those workers who were compelled/

compelled to work in a constrained position with the visual regard directed upwards; but he held the cause to be in the first place lack of light.

That deficient light is the essential factor in the causation of miners' nystagmus, was advanced in the year 1878 by Romiee in Belgium, and in this country by Court in 1891. Romiee maintained that excessive accommodation for a long time in a bad light is the chief factor in the production of nystagmus. In 1908, in "Le Scapel", he made another communication and ends up in the following words: "L'éclairage insuffisant est la cause unique de la production du nystagmus des houilleurs." The question of the comparative influence of naked lights and safety lamps (the naked light being the stronger illuminant) was investigated by Sir J. Court, and he reported to the Derbyshire Miners' Association in 1891, laying the greatest stress on the importance of illumination in the causation. He says where open torches, candle-power $2\frac{1}{2}$, are used, there is no nystagmus at all.

This view being in direct opposition to the Constrained Position Theory of Snell, led to much discussion, but the trend of opinion favoured Snell's.

In the year 1887, Jeaffreson in the B. M. J. propounded his view, which is really an elaboration of Snell's Position Theory. This author maintained that the disease is a general one, with nystagmus as one of a group of symptoms. He suggested the name of Miners' Neurosis, and that it is brought about by fatigue which follows the dissociation of movements normally combined, e.g./

e.g., flexion of the head with elevation of the eyes. This view was upheld by Rutten from 1908 up to the present time. To this view the name of "Gegenrollung" has been given by the Germans.

In the year 1906 the equilibration disturbance hypothesis made its appearance. A. Christie Reed attributes the condition to imperfect fixation due to a dim light and frequent disturbance of vision. All the muscles are involved, as there ought to be hyperphoria present if the elevators alone are affected. He says that fatigue is not sufficient.

May 22nd, 1907, was a memorable day in the history of the coal mining industry, as the disease was included among the scheduled industrial diseases of the Workmen's Compensation Act of 1906. Nuel of Belgium, in an important paper read before the Royal Academy of Medicine of Belgium, clearly established the claim of Miners' Nystagmus to be considered as an industrial disease causing real incapacity. Further prominence was given to the condition when, in 1913, the definition of the disease under the 1906 Act was altered by the Secretary of State from the original "Description, Nystagmus. Process, Mining," to "The disease known as Miners' Nystagmus, whether occurring in miners or others, and whether the symptom of oscillation of the eyeballs be present or not."

In 1908, Nuel maintained that the chief factors in the production of the condition are darkness of the mine and the crystalline fracture of the coal with prolonged elevation of regard, and that one factor alone is not sufficient.

"Is/

"Is nystagmus of Labrynthe Origin?" is another view of the pathology of the disease put forward by Peters in the Archives of Ophthalmology in 1907. The nystagmic patient often tilts the head backwards, and this has led Peters to ask whether such a position is a primary one or one designed to overcome the upward movement of the eyeballs. Ewald and Ach oppose this view and point out that when the head is placed in the abnormal position of torticollis, nystagmus does not result. Labrynthine irritation was assumed by Trombetta in the year 1907 to be the cause. This is supposed to be brought about by the frequent and rapid change in the atmospheric pressure and to incessant blows of the pick and shot-firing.

The thoroughness with which Snell propounded his theory has found no equal. The one object of his work is to discount the influence of feeble illumination in the causation of the affection, and his theory held its ground up to about 1910, when a fresh generation of investigators and workers seemed to have reversed the current opinion, and the view, "that the chief factor in the etiology of the disease is the deficient illumination present in the mine," so stoutly defended by Romiee and Court, gained prominence and acceptance, so much so that the Oxford Ophthalmological Congress in 1912 passed a resolution endorsing their view unanimously.

During this period the number of investigators was numerous, and the most outstanding ones are Llewellyn, Stassen and Ohm. Llewellyn was the first Tyndall Research student, appointed in 1910/

1910, and he proved by actual photometric measurements of the amount of light falling on the coal face, and found that the miners work in a very deficient illumination. In 1912 the study of the tracings of nystagmic movements was undertaken by Coppez, and he came to the conclusion that nystagmus is due to an incomplete tetanus, the result of fatigue, and that all the muscles are affected.

Dransart returned to the subject in 1913, and while still holding that the prime cause is the direction of the gaze, he thinks that the deficient light is a secondary cause, and that with improved illumination the primary cause will disappear.

Wilson (1913-15) holds that the feature common to ordinary and miners' nystagmus is the imperfection of the retinal images. In his Milroy Lectures in 1914, Shufflebottom considers the disease due to deficient light, cramped position, refractive errors, and ocular injuries at work.

"That fatigue in the execution of ocular movements is only the clinical manifestation of miners' nystagmus" has been put forward by Stassen. He lays great stress on the physical condition of work producing a nervous syndrome characterised by inco-ordination and the exaggeration of the visual reflexes. After treating the subject from every point of view, he comes to the final conclusion with these words: "La cause necessaire est suffisante dans de mauvaises conditions d'éclairage" and "Le fait est donc certain: les troubles visuels des mineurs relèvent de la physiologie de la fatigue, dans de mauvaises conditions d'éclairage."

"That/

"That miners' nystagmus is a disorder of tone, produced by by the labrynth, in different muscles or muscle groups," is advanced by Ohm of Westphalia. Lack of light and unfavourable conditions of work are the occasioning factors of the disorder, and these give rise to too strong and too infrequent innervation of the labrynth, hence a disorder of muscle tone. Contending that the disease varies directly with the amount of labrynthine disturbance and inversely with the illumination present, he believes that a pit lamp giving 2-3 candle power under unfavourable conditions would diminish the number of cases.

In 1920 Martin, thinking that there is a similarity between cases of nystagmus and anxiety neurosis of the war-strained, puts forward that "the disease is essentially one of exhaustion." Anderson in 1920 holds that astigmatism is the most frequent cause of the condition, and he suggests examination of all men before employment.

Upon the recommendation of the miners' Light Committee the Medical Research Council at the request of the Home Office, appointed a Miners' Nystagmus Committee in 1920. The result of their deliberation is the cry for "More Light."

The latest contribution to this subject is by Dr. F. Robson of Penarth in South Wales. His contention is that poisoning by the absorption of mine gases - carbon monoxide or some symbiotic combination of gases - is the cause of Miners' Nystagmus. He also sought to prove that the incidence of the condition bears some ratio to the nature of coal worked, as various kinds of coal/

coal show differences in the percentage of their volatile contents. Therefore according to him the higher the volatile content of the coal worked in an area, the greater will be the incidence of Miners' Nystagmus in that area. This gas poisoning theory was enunciated by Pechdo in 1893 and supported by Harrison Butler at Oxford Ophthalmological Congress in 1912, by Coulter in 1914, and Leighton Davis in 1920.

It is interesting to note that, though the constrained position theory of Snell has given way to the cry for "More Light," the view on the pathology of the disease has also changed. The condition considered to be a local myopathy of the elevator muscles of the eyes of the result of excessive accommodation - purely local condition - is now held to be either a general fatigue of the whole oculo-motor system, or a general neurosis with special local manifestation in the oculo-motor apparatus.

THESIS OF MINERS' NYSTAGMUS.

Etiology.

Coal miners' nystagmus - the cancer of the coal-mining industry - is one of the most common causes of disability in underground workers. Peculiar in that it only affects the workers of the coal-mining industry, as it is unknown in all other mining industries, e.g., lead, diamond, tin, etc., it has resisted the attempts of three generations of investigation to elucidate the mysterious causal factors in its production.

Snell of Sheffield in the year 1875, following the publication of cases by Deconde of Belgium, recorded the fact of the association of nystagmus with miners engaged in a particular kind of work in the coal pit called "holing". Considered adequate to the explanation of the phenomenon, the views of Snell are practically always quoted in text-books; but broadly speaking, the various theories - which are innumerable - as to the causation of the signs and syndrome of symptoms of this condition, may be cast roughly into three categories:-

1. That the peculiar position of the eyes necessarily maintained by a limited class of miners engaged in a particular branch of coal-mining is the principal factor in the production of miners' nystagmus - Position Theory.

2. Insufficient/

2. Insufficient illumination when using the eyes is the main factor - Illumination Theory.

3. That the disease is caused by poisoning with mine gases, has lately been revived and amplified by Dr. Robson of South Wales - Gas Theory.

The chief adherent of the position theory was the late Mr. Simeon Snell of Sheffield. He came to the conclusion that the nystagmus of miners was a myopathy dependent on the peculiar position assumed by a certain class of men in the mines. "Of all the many instances which have at different times come under my notice, with very few exceptions, the miners have been those whose work has been done on their sides more or less connected with the work called "holing." It is, I believe, a myopathic disease, a local affection. Chronic fatigue in the ocular muscles if brought about, and atony being induced, oscillation of the globes is caused. Later researches have substantiated in the fullest manner those already published."

This is the generally adopted theory. To discount the influence of defective illumination in the causation of the phenomenon, was the main object of Snell's work; though he had admitted that "the worse the light, the greater will be the effects of the strain experienced." This conclusion finds support in other investigations, notably by Dransart, who in the "Annalis d'Ocultistiques," contends that the condition results from muscular strain in the lying position, but he differs from Snell as to the precise muscles affected. Other supporters/

supporters are Carter and Frost who state, in writing on the condition in their book on Ophthalmic Surgery, that "it only occurs in those who work in the lying down position."

The thoroughness with which Snell propounded his theory has met with no equal as far as an oppositional theory is concerned, though at different times various observers have put forward views more or less at variance with this. For example, Jeaffreson (B. M. J., 1887) of Durham thinks that the nystagmus is caused by the cramped position, such as sitting on the haunches, giving rise to "cerebral anaemia", but "chiefly of those parts which derive the blood supply from the vasilar arteries, i.e. the occipital lobes. This is caused by pressure of the linterial ring on the upper part of the pons." Though no "holing" is done in his part of the Durham coalfields, the cramped position, he says, leads to a "dissociation of naturally associated centres." He does not seem to consider that the question of light has any place as a causal factor, but he proposed to change the name from "miners' nystagmus" to "miners' neurosis" because of the often associated general nervousness.

On the other hand, Neiden, Priestley, Smith, Eales, Taylor, Court, Llewellyn, and others, hold that insufficient illumination and consequent imperfect stimulation of the retina, and therefore of the co-ordination centres, is the principal factor.

Classification of miners' nystagmus in our general scheme of disease has been attempted by some observers, notable amongst whom is Bell Taylor who, in 1875, places it along with other occupation neuroses, such as "writers' cramp." He says that fatigue/

fatigue of the eye muscles necessitates a series of little successive and rapid contractions. It then produces nystagmus. As late as 1887 (LANCET) he wrote again, that, "miners' nystagmus appears to be a pure myopathy and strictly analogous to writers' cramp."

From my personal experience in the Rhondda Valley coalfields, I do not think that the theory of Snell and his supporters, that miners' nystagmus is produced by working lying down or in a slanting position with the visual regard directed upwards, is sufficient to explain everything, as all underground workers are liable to the affection - labourers, repairers, hauliers etc. The ostlers do not often get it, and it is a noteworthy fact that the stables are electrically lighted, as a rule, and white-washed. In my collection of cases, I find that I have only one case who is an ostler. (Case 23 W. H. M. Age 29 Ostler-helper and then ostler. Certified 23/3/23. Resumed underground 10/8/23. Never did any other work before.)

In this district two kinds of coal are worked, known as "House coal" and "Steam coal", the latter chiefly. House coal is only found in thin seams rarely over $2\frac{1}{2}$ feet, and that as a rule, not being very "fiery", it is worked by "naked eye" illumination. On the other hand, the Steam coal is in thick seams varying from 4 to 9 feet, some even thicker than that. It is much more "fiery", and safety lamps (electrical since 1914) are employed in working it.

Snell's contention is that the disease is practically confined to those engaged in the process known as "holing". This process of/

of "holing" for coal is accomplished by the collier cutting some 18 inches or more under the seam, and then wedges are applied above forcing the coal down. To make this hole underneath the seam, the miner has to lie on his side with the eyes directed obliquely upwards, according to Snell. He thus works in a very constrained position, and often with very feeble illumination, as he may have to hole for a yard or more under the seam with an unbroken black background.

In South Wales "holing" is comparatively little practised, nearly all the colliers working on the "long wall" system, but what "holing" is done is confined to the "House coal" workings. Even when these are worked on the "long wall" system, there is very little room, and the collier has to work in a bent or somewhat recumbent position. On the other hand, a Steam coal worker has as a rule plenty of head room. The eyes are directed probably as much forwards and downwards, as they are obliquely upwards, according to Snell.

Here we have two sets of miners to judge from; the "House coal" men working more or less on their sides with extremely limited head room, comparatively little dust, and usually naked light. In the second set the miner has plenty of head room, works in very varied positions, but as a rule standing.

If the lying position of the body, and the oblique direction of the visual regard, were the essential factors in the etiology of the phenomenon, then we should expect the first set of miners to develop nystagmus. As a matter of fact, however, nystagmus is/

is comparatively unknown among "House coal" workers.

Workers underground in coal mines may be divided into six main groups:-

1. Colliers - those actually engaged in cutting coal.
2. Hauliers - those who convey the coal in transit to the shaft.
3. Labourers - who clear the headings and stalls.
4. Repairers - who look after the roof, etc.
5. Timbermen and assistants.
6. Other workers.

Nystagmus is certainly much more common in colliers, but cases in other groups do occur.

The following is a Table of the occupational incidence of miners' nystagmus in my list of cases.

OCCUPATIONAL INCIDENCE.

Number of Cases, 185.

Colliers	68.2%	126
Hauliers	13.5%	25
Repairers	6.5%	12
Labourers	4.3%	8
(Timbermen and Assistants)	3.2%	6
Other workers	4.3%	8

(Rider 1, Contractor 1, Wireman 1, Slummer 2, Spragger 1, Riffer 1, Ostler 1.)

From these figures one can see that every class of underground/

ground worker is affected, but the most skilful workmen are much more affected, and they are the colliers, and they represented 68.2% of my total cases. Indeed, T. Lister Llewellyn, according to his list showed that they represented 81.63% of his cases, whereas Snell gives 96%, and Jeaffreson "confined to coal hewers practically without exception."

Inquiring amongst all kinds of colliery workers from officials downwards, I find that the prevailing opinion in relation to the etiology of the condition, is that the illumination is the cause, and probably 99% of the colliers are in favour of the "light theory" rather than the "positional" one. Talking to the older generation of colliers, one finds that they blame the safety oil lamp; but this does not count much as they are well known to be hostile to their use, owing to the smell of the fumes from the lamp fastened to the waist-belt or held in the mouth. Others will say that they were all right until they started to use electric lamps, when they contracted the disease. The number of oil lamps in use nowadays is very small indeed, as since 1914 the oil lamp has been progressively replaced by the electric pattern. Still, it is the illumination theory that they favour. If it is simply a case of long-continued muscular strain in a peculiarly unnatural position, how is it that we do not find nystagmus amongst those who are constantly engaged in ceiling decoration, white-washing and allied occupations?

It is probable that nystagmus may be the resultant of a combination of causes, so it is as well to look into the various conditions, which might determine the occurrence of the disease:

A. Seasonal Prevalence.

In my experience I find that there are many more cases presented for certification in the winter than in any other season, whereas in the summer months the number of cases is at a minimum. Probably the absence of sunlight, and therefore proper retinal stimulation during these dark months, upsets the balance of the latent cases and converts them into manifest ones.

Seasonal Prevalence: 185 cases.

Winter:	Dec. to Feb.	61	32.9%
Spring:	March to May	54	29.1%
Summer:	June to August	30	16.2%
Autumn:	Sept. to Nov.	40	21.6%

From this table one finds that there are twice as many cases in the winter months presented for certification than in the summer months. These figures are comparable with those of Dransart in 1910.

1st Quarter	31 %
3rd Quarter	16.6%

B. AGE.

It may be said that the longer a man works in the pit the more he is likely to get nystagmus. The mean or average age of the workmen at the time of failure is variously stated by various observers.

The following is an analysis of 185 cases which I have observed in my own practice. Six of these cases are recurring cases/

cases and are counted as fresh cases, whereas 9 of the fresh cases had relapses.

My mean average age is	41 years
" " years of underground life is	29.3 years
" oldest case is	69 years
" youngest case is	16 years

T. L. Llwellyn gives his mean average age as 39.33 years and his mean years of underground life as 25.94 years.

Elworthy of Ebbw Vale gives his figures as 35.5 years and 21.25 years respectively.

Number of cases per quinquennial periods.

Age.	No. of Cases.	Age.	No. of Cases.
15 to 20	4	40 to 45	29
20 to 25	15	45 to 50	34
25 to 30	10	50 to 55	17
30 to 35	24	55 to 60	22
35 to 40	24	Over 60	8

The greatest number of cases are seen between the ages of 40 and 50.

Young cases are very severe, and it is interesting to note that 17 of my cases developed the malady before 25 years old, i.e., only about 10 years underground life. It is in these young cases that one finds an acute onset mostly, that is they have never had any suspicion of their eyes being in any way afflicted beforehand. Then oscillation starts all at once, and accompanying same one generally finds photophobic headache and often giddiness./

giddiness. Ten out of the 17 had acute onsets and a few blame it to some accident or illness preceding the attack.

Case 8. L. J. Age 19. Four years collier boy: had foreign body in eye in July; out 14 days; returned to work. A week after starting, developed nystagmus with photophobia: certified on 28/8/23; returned to ordinary work on 30/5/23 underground.

Case 11. F. L. Age 16. Less than one year underground (8 months); certified 23/1/23 violent nystagmus, with headache, photophobia. Had scarlet fever at 14 years complicated by albuminuria at third week. Improved and sent to the surface 19/11/23. Now fully recovered.

The other 7 have had experience of oscillation before incapacity.

Case 13. T. W. T. Age 22. Collier. Certified on 31/3/25. Following scalp wound. Felt eyes going for twelve months before incapacity. This case shows Blepharospasm as well but not marked. Totally incapacitated still.

Case 12. T. H. Age 21. Collier. Certified on 6/3/24. Sent to surface work on 23/3/25. Nystagmus still present. Hysteria marked in sister and mother. Father suffers from Parkinson's disease. Two of these cases are epileptics, with marked family history.

Case 1. T. G. Age 24. Collier. Certified on 10/4/19. Resumption to surface 3/9/19. Eyes known to him to be bad for three years. He has marked Petit Mal and marked myopic astigmatism. Left the district ultimately. This case went to work on/

on the surface after 5 months' rest.

Case 10. J. B. Age 19. Collier's boy. Certified on 23/1/23. After resting was put on the surface on 19/11/23. He kept on the surface till 9/2/25 and then failed to work there. Major mal. He accepted a small sum from the colliery company and gave up any claim. Marked family history.

Three cases have error of refraction. Two marked myopic astigmatism, the other hypermetropic astigmatism.

Case 9. J. J. Age 24. Repairer. Certified on 3/3/23. Sent to surface 2/10/23. Nystagmus still present. Fair blue eyes with hypermetropic astigmatism.

The average time of those who returned to work either on the surface or straight to underground is 7½ months.

What happened to these cases:

Three still totally incapacitated, but improving.

One bought out by company (Epileptic).

One left the district ultimately.

Four resumed underground work direct.

Seven remained on the surface for varying periods, but have now all returned to the usual work.

One became a milk roundsman (Epileptic).

From these figures of young cases, I think I may state that the younger the age of affliction, the greater the chances of ultimate recovery. The reverse is also true.

Some of these cases have recurrences:-

Case 2. W. S. Age 22. Collier. Eyes known to be bad for four/

four years before certification on 24/10/19. Resumed underground work direct on 24/11/20. Recurrence on 22/2/23 and was sent to the surface. Then he gave up work and became a milk roundsman and certified free from nystagmus on 18/2/24.

Case 3. E. J. B. Age 20. Six years labourer and late collier's boy. Certified on 11/9/20. Resumed to surface 15/11/20. Worked there till 15/7/21, then resumed underground as collier. Three months after he was re-certified on 13/10/21. After 9 months' rest he resumed on 6/7/22 as a collier and failed again in two months on 1/9/22 and from then onwards he was sent to the surface where he remained till 18/8/23, when he again descended the pit shaft and became a collier with no further complaint. The case is interesting on account of the frequent change of occupation and frequent break-down with ultimate alleviation of his affliction.

I have said that the younger the cases the greater the chances of ultimate recovery, and I may also add that the younger the cases the less time they will take to return to do some work, as in these young cases the average time of incapacity is only $7\frac{1}{2}$ months.

The greatest number of cases are seen during middle life, between the ages of 40 and 50.

That aged cases do recover from this malady ultimately is evidenced from the following cases.

Case 18. J. R. Age 59. Underground 50 years. Master haulier./

haulier. Certified on 2/10/20 with simple oscillation of eyeball and resumed underground work as haulier on 13/12/20 with no further complaint. This man's incapacity for 2½ months or thereabouts is interesting. He worked for another 4 years and retired. Unable to elicit nystagmus from him now.

Case 19. J. J. Age 66. Underground 55 years. Repairer. Certified on 7/11/22 oscillation of eyeball, headache. Re-examined on 9/7/23 after 8 months rest and certified as free from nystagmus by medical referee.

Case 20. D. J. Age 69. Sixty years underground, haulier; certified on 30/1/23 and discharged on 8/1/24 by the medical referee as free from nystagmus. This is my oldest case.

From these cases, one may say that recovery, even when certification takes place at an advanced age does occur. Therefore age does not play any part in the etiology of nystagmus, except that the longer a man works in the pit the more likely he is to get nystagmus, and that all ages are attacked.

That the younger the case the greater is the chance of ultimate recovery.

That recovery does take place in some cases certified at an advanced age.

That the greatest number of cases are seen between the ages of 40 and 50.

That in those attacked young, it does not necessarily mean giving up underground work except those complicated by nervous diseases, and that recurrences do happen in the young.

That/

That young cases are often accompanied by symptoms of headache, photophobia and giddiness, and that acute onset is usually seen in these cases.

That the mean average age is 41 years.

That the mean average years of underground life is 29.3 years.

That the oldest case is 69 years at first certification.

That the youngest case is 16 years at first certification.

C. Accident and Illness.

On analysis of my cases, I find that nearly half of them complain of some accident or illness which has ushered in an attack of nystagmus. "I was all right until I had that attack of influenza," and so forth.

Below I append my findings in the 185 cases.

After influenza	36
After various illnesses - pneumonia, etc.	24
After accidents in general	30
Without cause at all	95

Out of the 30 cases developing after accident:-

15 resulted from blows on the head and face.

6 " " " " " back and legs.

9 " " " " " eye, and foreign body in the eye chiefly.

I do firmly believe that accidents and illnesses have nothing to do with the etiology of miners' nystagmus as primary or causal factors; but I am thoroughly convinced that accidents and/

and illnesses, by rendering the muscular and nervous system below par, have everything to do with converting a latent case into a manifest one. The line of demarcation between the latent and the manifest cases is so thin that any injury, shock or acute illness will easily aggravate a previously latent stage without incapacity to one with all the clinical features of a manifest case. I do not suggest that accident or ill-health will bring out the disease in a man who had not been exposed for some time to the working conditions in a coal mine. The following cases are interesting and bear out my statement:-

Case 21.

J. M. Age 44. Collier.

Had foreign body in the cornea, which had not been seen for three days. On presentation for examination, his right eye was very inflamed and angry-looking. A piece of steel filing was seen first below the pupil buried in the cornea and surrounded by a yellow ring. Filing removed under cocaine; the eye was very acutely inflamed for a fortnight and then slowly cleared up. He was out for five weeks in all, and returned to work on 22/12/19. He reappeared on 30/12/19 with well marked nystagmus, which was not present when I first treated him for the foreign body in the eye. The eyes were watering, photophobia, blepharospasm and headache were present. He was certified. He was out of work since certification, and developed neurotic symptoms. On 21/10/27 he was certified as being fit for employment underground by myself, but was given work on the surface by the company surgeon, who feared/

feared a recurrence, though I could not elicit oscillation. Blepharospasm and neurosis disappeared. He worked for two months, and was discharged along with all the other hands, owing to the pit surface being done away with, and the coal sent to another pit underground for haulage to the surface. This man, not having sufficient insurance stamps to go on the register of the Unemployment Exchange, was forced to apply to the Parish for relief, as the company stated that they were not liable for him any longer, although they refused to give him his usual work underground. On February 18th, 1928, he appeared before me, another ulcer in the cornea with watery eye, injected conjunctiva and blepharospasm, but I could not elicit any oscillation of the eyeball by any method, and he is still without redress.

This case shows the following points:-

1. That nystagmus becomes manifest after injury to the cornea, and that a man perfectly free from nystagmus presents a typical clinical picture shortly after an accident to his eye.

2. That injury does not bring out oscillation of the eyeballs in a miner who has not been exposed for some time to the working conditions of the coal mine.

3. That a man is refused his usual work after an attack of nystagmus, because of fear of recurrence. What is his redress?

Case 22. T. P. Age 46. Collier. Had influenza on 2/10/21. Went back to work 15/10/21. Eyes went bad since the influenza attack; they were not well before, but unable to work properly on account of headache and bad sight. Certified on 21/10/21. Rested for 9 months and resumed work underground on 10/7/22. Worked/

Worked on till 14/2/24 when he received a foreign body in the eye which precipitated another attack, and after resting for about 5 months was sent to the surface on 7/7/24 where he remained till 12/10/24 and resumed underground work.

This case illustrates how influenza precipitated an attack of nystagmus followed by a recurrence ushered in by a foreign body in the eye. This man in the time between the first and second attacks had been subjected to the usual conditions associated with underground work.

Case C. from my record of uncertified cases is very interesting.

W. T. Age 28. Healthy fair man of good physique. Hard worker. Been underground 14 years and has not known a day's illness. Two years ago 18/2/26 he had an alveolar abscess, and was advised by the dentist to have all his bad teeth out. He took advantage of the Dental Benefit under the N.H.I. Act and had all his teeth extracted under novocaine (?) in three sittings (27 teeth in all) at intervals of three days. After the last batch was removed, he developed acute gastric catarrh with flatulence and tenderness. Palpitation is prominent, and general nervousness. He was treated for a fortnight; the stomach improved, but palpitation is severe sometimes at night. He returned to work and after a week he showed marked oscillation of the eyeball, which was not present before. As his eyes were not giving him any trouble, he continued on working without any handicap, although oscillation is marked if he is asked to look/

look upwards. He is improving in general condition, and his eyes are still giving him no trouble, although there is still oscillation. He had 9 months' rest from May 1926 on account of the general strike, which improved the eye condition for him. There is nothing to prevent this man becoming certified during the strike but he did not.

This case shows that an attack of oscillation of the eyeball was set up after an acute illness, and that a man with oscillation of eyeball does not always mean loss of work though he is conscious of oscillation.

Therefore one may state from the above that accidents and illnesses, giving rise to general body and nervous exhaustion, have a great deal to do with converting latent cases into manifest ones, but as primary factors in the causation, they can be ruled out. Most of the cases enjoy good health and present no obvious physical changes; and considering that nearly from 40 to 50% of all underground workers are said to be nystagmic and that only 0.05 to 2% show any incapacity at all, then the rest without incapacity must also be unhealthy if general body and nervous exhaustion have anything to do with the disease as primary factors. This is not the case, as these latent cases are men of good health and physique and doing hard physical work. Again, the miners' work is by no means unhealthy. Statistics have shown that even when fatal accidents are included, the death rate amongst miners is not excessively high, and if accidental deaths are put aside, the death rate from diseases/

diseases alone is fairly high, but only about the same as that of agricultural labourers.

D. Method of Work.

As the prime cause of nystagmus is thought by many to be the resultant of the actual work of a miner, it is necessary to understand that there are many distinct varieties of work in progress in a coal mine.

Coal is got in one of three ways:-

1. By "holing."
2. By taking advantage of the natural cleavage lines of the coal.
3. By the use of coal-cutters.

"Holing" is divided into top, middle and bottom holing, bottom holing being the commonest. It consists in undercutting the lower portion of the coal on the underlying clod to a distance of anything from 18 inches to 6 feet. The coal is being struck with the mandril and every blow is placed. When the coal has been undercut, a certain length of the coal face is freed by cutting at right angles to the surface at the sides or ribs, and the coal is finally obtained by wedging the mass down from the top. The method of "holing" varies with the seam. In this part (Rhondda) the collier working in the house-coal seams kneels, holding his body a little obliquely, and keeps his head against the roof. In thinner seams, they work in a semi-reclining or completely reclining position. In the semi-reclining position, he lies with one leg drawn up under him,/

him, and the lower shoulder just clears the ground. In the complete position he lies on the under-shoulder. In Wigan, where I paid my first visit to coal mines, the seam is 6 feet thick. The colliers here lie on the side, and he may have to hole 5 or 6 feet from back to front. As he progresses, he insinuates his body into the cleft he is excavating, which decreases in height at the back. Top "holing" is done when the top rock is much softer than the bottom, or because the coal is much softer on the top of the seams; but on the whole, one might say that "holing" is done in the place which offers the least resistance to the pick. House-coal colliers in cutting coal near the roof have to look up, but rarely has a steam-coal collier to cut coal on the top. I have known colliers suffering from nystagmus complaining that they have trouble with their eyes when doing this. This class of work is also done by "rippers" who rip down the roof with their picks, and as they work with their eyes directed upwards, yet the incidence of the disease amongst them is very low, and much lower than that of the labourers. In my 185 cases I find only one "ripper" has certified nystagmus.

Taking advantage of the natural cleavage lines in the coal and relying on the pressure present to squeeze out the coal when one end has been freed, is the method chiefly employed in obtaining coal in steam coal pits of this area of the Rhondda. The work requires very little skill, except in taking good care of the roof.

The/

The third method of "winning" coal is by the use of mechanical coal-cutters, which do all the necessary under-cutting, and all the men have to do is to wedge the coal down from the top.

The idea that the "holer" works in a very constrained position, and that the miners at the coal face are the ones in the main who develop the disease, has led Snell to concentrate his whole force to prove that the "holers" were the vast majority of the cases. He says: "I am satisfied that any competent investigator approaching the subject with an open mind can arrive at no other conclusion than that the prime cause of the peculiar oscillation of the eyeballs from which miners suffer is the position into which a certain proportion of coal getters have to throw their eyes whilst at work - the kind of work is called 'holing'." He also states: "The men described as working straight forward "cutting" or "heading" do not, according to my observations, suffer from nystagmus. The occasional instances met with in fillers will readily be explained when analysed, and will be found not to be at variance with my contention that miners' nystagmus is associated with the work called "holing," or one necessitating a somewhat analogous attitude of the eyes."

In my experience here, where no holing is done, nystagmus is rife.

Jeaffreson states that nystagmus is frequent in Durham, where no holing is done.

A. C. Reid of Nottingham, in his experience of Yorkshire mining/

mining at Hicklemain, says that the seams are 8 feet thick and no "holing" is done, but nystagmus is also frequent.

T. Harrison Butler says: "Nystagmus is not, as Snell and Dransart would have us believe, confined to the "holers"; it is more common in these men, but is often seen in all men who work in the pit."

J. Court, in his pamphlet, which describes his investigations, admits the large percentage of cases in "holers" and part-time "holers," but after an interesting comparison as regards illumination, attaches no importance to the position or kind of work. He says that position has very little, if anything, to do with it.

H. S. Elworthy of Ebbw Vale writes: "As to the theory that nystagmus is produced by working while lying, I can give no opinion, as the great majority of colliers of Ebbw Vale Collieries, I am told, work in the upright position; - - - and besides, other underground workers get nystagmus, such as hauliers, timbermen and repairers in coal mines."

Personally, I have seen colliers at work at the coal face in South Wales, and in doing "holing" their attitude is that of kneeling, and holding their bodies a little to one side with their heads against the roof. The direction of their regard here is downwards. Even in the semi-reclining position of "holing," I wonder whether the attitude is so constrained to a collier, though it appears so to a novice. One must remember that every stroke of the mandril is placed, and it must/

must be used with a full swing, otherwise the stroke will be ineffective. If his position is constrained, then how can he employ his pick with success? Again, one must remember that a collier begins working as soon as he leaves school, i.e. about fourteen years (much younger in olden times) and he is accustomed from youth to work in positions with ease, which other people find impossible. In South Wales a collier has not only to win coal, but he has to fill the trams and attend to timbering and therefore they have relief from this constrained position. Above all, a good collier who has been accustomed to working in a large seam for life, will not make much of a living if shifted to a small seam.

Is "holing" of any importance to the causation of miners' nystagmus?

A good "holer" depends on the accuracy of the blow of the mandril on a fixed spot, otherwise he will lose work. He lies in a cleft, of which the only three sides he can see are composed of coal, and owing to the great absorption of the light by the coal, the amount of light reaching the point he is striking is very small.

Therefore "holing" throws a strain on the eyes in the absence of sufficient light.

The fact that collier boys and ostlers suffer from the disease, yet they have never done any "holing", is another instance against the idea that "holing" is the prime cause. For example:

Case 8./

Case 8. L. J. Age 19. Four years collier. Certified on 28/8/22 following foreign body in eye. Resumed underground work 30/5/23 without further complaint. He is working with his butty on the "long wall" system in a steam-coal pit. There is no holing done here.

Case 23. W. H. M. Age 29. Ostler-helper, then Ostler. Certified on 23/3/23. Resumed 10/8/23 with nystagmus still present. Never did any other pit work before.

Arduous is the work of the South Wales timberman and repairer, because the pressure of the roof is great. They have to erect timber to support the roof and sides, and also to repair holes in the roof resulting from falls. They do much of the work with the eyes directed upwards, and here the upward glance, insisted on by Snell, is present; but then these people find that the light in the holes is generally poor. The fact that hauliers and men connected with the haulage ropes are also attacked is fatal to the position theory, and they gave 13.5% of my total cases.

Case 18, is a case in point. He is a master haulier, who directs all the other hauliers and gets them out of trouble where required in his district. He has never done a day's work in any other capacity.

Deputies or deputy managers have, inter-alia, the care of the ventilation of the mine, and they frequently have to explore the highest parts for gas, and ascertain the condition of the roof, both of which duties involve the upward glance, but they have to work with very little light in gas-testing. The testing for/

for gas consists in turning down the wick of a safety lamp, so as to decrease the light, and if gas is present on inspection of the flame, a blue "cap" appears on top of the yellow flame, varying in height according to the percentage of gas present. Snell has proved that a deputy suffering from nystagmus is incapable of seeing this blue "cap", and consequently is a danger and a menace to the safety of the mine.

E. Ocular Defects.

The importance of errors of refraction upon the incidence of miners' nystagmus, has exercised the minds of a good many investigators. Some men are able to spend a life-time underground without ill effects, while others may develop the disease in six months. Again, why should men working under precisely similar conditions suffer unequally? It is a well-known fact that, of the miners working under almost identical conditions in a certain seam, only a certain percentage develop nystagmus. Is it because some men are unable to stand the strain of the pace at which the modern mine is worked, or is there some personal defect? The disease has been shown to attack those men who use their eyes the most in a much larger proportion than that of other workers.

In my experience, the majority of my cases have very fair vision. Many can read the 6/6 line with no difficulty, others are unable to do so at all on account of violent oscillation. The generally accepted view is that in the absence of movement, vision is little or not at all affected. My own figures show that/

that 60% can read the 6/6 line with no difficulty at all. In the acute stages of the disease, vision is limited, and in these cases the gradual improvement as the nystagmus becomes less marked, is very interesting to note. I have always taken the amount of acuity of vision as a measure of the severity of the attack, and the improvement as a sign of the progress of the recovery from the disease.

Errors of refraction as a predisposing factor upon the incidence of miners' nystagmus has been delegated to a place of no importance by the earlier investigators of the disease; and amongst them are Snell, who stated that, out of his 127 cases, only 9 showed marked error of refraction, and Dransart who stated that 90% of his cases were emmetropic. Roimee says that the cases are rarely emmetropic, most are hypermetropic, often to a marked degree, but he abandoned the idea eventually.

Brown and Mackenzie in the B.M.J. (5/10/12) state that errors of refraction were present in 90% of their cases; T. Harrison Butler, at the Oxford Ophthalmic Congress in 1912 said that 45% of his cases had errors of refraction; while G. H. Pooley, F.R.C.S., in the report to the Medical Research Council, says that "errors of refraction have no effect whatever on the incidence of miners' nystagmus."

It may be said that most authors think that error of refraction is of no importance in the production of the disease. The great number of cases of nystagmus with normal vision in my practice, coupled with cases of high myopia, who have been working/

working underground for 30 to 40 years and have not developed the disease, has led me to believe that errors of refraction have no relation to the incidence of miners' nystagmus. Yet I have seen a case of high myopia in a non-miner giving rise to nystagmus; but here the irregular jerky movement of the eyeballs is nothing like the fine rhythmical oscillation of the eyeballs in the miners disease.

The following case is interesting and will show the relation of eyesight to miners' nystagmus and incapacity arising therefrom.

Case 24. B. T. Age 46. Collier. Had an attack of acute bronchitis in 1922. Out for 2 months. Eyes troublesome before then. Vision 6/9. Certified on 4/8/23. Marked oscillation, redness of conjunctiva, lachrymation and blepharospasm. Orientation on coming into the lighted surgery. Total incapacity. In 1926, a cricket match was arranged between two political clubs in the district, in aid of the soup kitchens organised during the general strike. This man scored 82 runs of the 112 scored by his club. The bowling was of no mean order. The management of the colliery heard of it and he was sent to an independent referee for examination and was certified as still totally incapable of doing any work. He remained out till 13/12/27 when he was declared to be fit for surface work, and as there was none to be had, he was put on the Unemployment Exchange, the colliery making up his differences. Here we have a man drawing money for total incapacity playing an excellent game of cricket and swiping a fast-delivered ball all over the place, with a deftness which was/

was much admired by all. This case shows that miners' nystagmus occurs irrespective of ocular defects; that oscillation of the eyeball does not interfere with his fixation of a fast delivered ball after a period of rest.

Case 25. E. W. Age 49. Haulier. Certified on 21/9/23. With no other features except violent oscillation. He is still totally incapacitated. The man is a voluminous reader, if he is wanted at any time during the day, he is to be found in the library. So long as he gets a good light during the day he can read. At night, with a kerosene lamp burning, he cannot read. There is no night blindness. His vision is normal. Here fixation is good, provided the light is good.

The examination in nystagmus cases for errors of refraction is beset with a great deal of difficulty. It is impossible to examine every case sometimes because of the severity of the oscillation and sometimes through lack of opportunity. Retinoscopic examination is impossible on account of oscillation plus the intolerance to bright light. Those who have had their errors corrected often find that the spectacles prescribed are irritating and intolerable and have informed others about to be examined that spectacles are useless and a waste of money to obtain them.

The larger proportion of emmetropia, as much as 90% given by Brown and Mackenzie, raises the question of the normal proportion of emmetropia in the general public.

Basing upon the work of Hernheisser, who examined 11,000 eyes/

eyes, and Hertel (12,331 eyes), Parsons published in his Pathology of the Eye (Vol. III page 931) a table showing that from the age of ten onwards, normal vision is found in 30% of all cases, hypermetropia in 50 to 55% and myopia in 10 to 15%. Randall in an examination of 200,000 eyes confirms these results. Steiger (p. 936 - ibid) says that there is an astigmatism of from .5 to 1D in two-thirds of all cases. The National Council for the Preservation of the Eye Sight published a little while ago a very interesting statement regarding the percentage of defective eyesight of the employees of one factory. In the factory employing 3,000 hands, no fewer than 2,160 were found to have defective eyesight, i.e., 72%. This figure is comparable to those given by Parsons' table, Randall and others.

This large number of cases affected in the general public reduces the importance of the figure given by Brown and Mackenzie (90%). Therefore, according to their figures, the percentage of refractive errors in nystagmus cases is about 10 to 20% greater than in the general public.

In order to clear up the question of relationship of errors of refraction to nystagmus, the Medical Research Council delegated G. H. Pooley, F.R.C.S., to investigate the matter and in his report he came to the conclusion that errors of refraction had no relationship to miners' nystagmus. This view confirms those of Snell, Dransart, Stassen and Coppez. The larger number of cases of nystagmus occurring in my practice, in which the vision is normal, discounts any influence of the refractive errors on the incidence/

incidence of the disease. If there is any connection between the two, there ought to be an increase of susceptibility to nystagmus on the part of the miners, and there ought to be much more nystagmus seen in the mining community, but this is not the case, as only 25% of the underground workers show oscillation, and only from 0.2 to 2% show any incapacity at all. Again, incapacity ought to be seen earlier in life, but here again the greatest number of incapacitated cases occur between the ages of 40 and 50, which produces 63 cases, whereas between the ages of 15 and 40 the total number is 75 cases, out of 185. Also the error of refraction should be greatest in those who are incapacitated at relatively early age, if there is any connection, but out of my 17 cases below the age of 25 only 3 show any sign of refractive errors.

Assuming that there is a connection between error of refraction and incidence of the disease, the most obvious ways by which the existence of refractive errors affect the incidence of nystagmus or the capacity attributed to it are as follows:

1. By increasing the miners' susceptibility so that -
   a. They are incapacitated earlier in life.
   b. The physical signs ought to be more pronounced in those with marked errors of refraction than in those who have none.
2. By increasing the duration of the physical signs and incapacity.

My figures show that the greatest number of cases seen between the ages of 40 and 50 produced 63 out of 185, whereas between/

between the ages of 15 and 40 we have only 75 cases. If there is a connection, then refractive error should be greatest in those who are incapacitated at a relatively early age, but here out of my 17 cases occurring before the age of 25, only three cases show any signs of refractive errors. The physical signs ought to be more pronounced, and duration of physical signs and incapacity ought to be increased, in those with marked errors of refraction than in those who have none. This is not my experience as may be illustrated by the following cases:

Case 38: W. E. W. Age 28. Collier. Certified on 21/7/19. Marked oscillation of eyeball. Myopic -6D both eyes corrected by spectacles. Resumed to surface 23/2/20. Worked till 9/8/20 there, and then resumed as collier underground with no further trouble.

Case 39: T. H. Age 46. Collier. Certified on 31/1/21. Myopic astigmatism, marked headache and giddiness. Relieved by glass

Rt. $-2.5 \; + \; -1.5$ Lt. $-3 \; + \; -3.5$

Resumed underground after about 18 months rest on 10/8/22 as collier with no further complaint.

Case 40: E. R. Age 42. Collier. Certified on 15/12/23. Headache and giddiness. Myopic astigmatism.

Rt. $-1.5 \; + \; -0.5$ Lt. $-2.5 \; + \; -0.5$

Resumed on surface on 29/7/24 and certified free from nystagmus by medical referee 18/11/24.

These/

These cases were all relieved by spectacles and along with the cases of high myopia who have been working underground for 20 or more years and have not developed nystagmus, coupled with the great number of my cases with normal vision, have led me to believe that errors of refraction bear no relation to the incidence of miners' nystagmus; but cases of very high myopia very often cause an increase in the length of incapacity in those who develop nystagmus. Personally I am often struck by the relatively larger number of short-sighted people in these districts than in other parts of the country, especially the number of high myopia. This is rather difficult to explain, but it may be assumed that those miners who have a tendency to short sight as the result of working without glasses in the poor light have become more myopic.

High myopia is commonly seen here both in the young and old and it is said that there is more high myopia amongst the miners than amongst other sections of the population. This larger percentage may be explained by the possible factor that in years gone by short-sighted men gravitated to the mines where the work did not require accurate distant vision, and as a result of working in the mines with defective illumination they have steadily become more myopic. Miners as a class detest glasses at work and it is a peculiar fact that they can work successfully with an extremely low visual acuity and very defective near vision. The following uncertified case is a good illustration. M. O. Age 42. Collier. Underground for 26 years. Myopia/

Myopia -7D both eyes. He applied for ophthalmic treatment under National Health Scheme. No sign of nystagmus. For instance, a miner who reads the inscription on the label of a bottle of medicine with difficulty, yet is able to go underground and earn good money at coal-getting is a peculiar fact. Perhaps the hereditary factor may have something to do with it, as it is seen in all ages and the hereditary tendency may also become aggravated by the fact that marriages of near relations are fairly common amongst the mining communities.

Case 26: G. C. Age 34. Slummer. Fair hair and blue eyes. Certified on 25/4/23. Oscillation of eyeball, marked headache, giddiness, lachrymation and Blepharospasm. High myopia, Right eye -10D. Left eye -13D. After seven months' rest he resumed on the surface. The history of this man is interesting. He had excellent eye-sight before the affliction. He says that he is an excellent rifle shot and has won many prizes in competitions. He was perfectly normal until they used electric lights when his trouble started. Since then his eyes became progressively worse until 25/4/23 when he could not work at all underground. Correction of the errors of refraction led to greatly improved sight, but marked nystagmus is still present and he has been working on the surface ever since. The oscillation has been greatly improved by the spectacles. A peculiar point is that, if he goes out in the morning without his spectacles, he can get along without them all day without any trouble occasionally. If he has his spectacles/

spectacles on in the morning, he cannot do without them as his eyes would be badly affected.

This case illustrates that a change of lighting has affected the eyes, and that he has become progressively myopic; that correction of refractive error has improved the oscillation somewhat, and that the eyes are much more comfortable with spectacles; that very high myopia is deterrent to complete recovery.

The following case indicates that a man with myopia without correction has become progressively more myopic, and the correction of his refractive error has enabled him to continue working, but on the surface with a rest of only six weeks.

Case 41. A. B. Age 31. Collier. Certified 28/6/20 with headache and giddiness. Myopia Right eye -6D. Left eye -6.5D. Following fractured rib three months previously, known to be short-sighted before, but detests spectacles. Errors corrected and he was placed on the surface six weeks after certification, where he is still employed working on a mortar machine, the movement of which often renders him giddy but he can carry on. Healthy man. Oscillation has improved, but he has left off his glasses as he detests them. If this man continues wearing his glasses, his eyes will improve sufficiently for him to return to underground work, but he does not wish to do so, as his weekly wage as a surface workman, plus the difference for partial compensation, amounts to a sum greater than he can now earn as a collier.

It is true that marked myopia can give rise to nystagmus, but the irregular movements of the eyeballs in such cases is not to/

to be compared with the fine, regular, rhythmical oscillation seen in miners' nystagmus as illustrated by the following case.

M. C. Age 17. Collier boy underground for $2\frac{1}{2}$ years. Marked myopic astigmatism $\frac{-3}{+}$-5.0 both eyes. Irregular movements of the eyeballs. Errors adjusted and he left the pit.

Heredity.

Is there such a characteristic trait or condition as one of predisposition to miners' nystagmus, and if so, may it be compared with that of tuberculosis, gout, haemophilia or hereditary ataxia (Frederick's disease), or is there some congenital morbid state of the constitution which the young collier inherits that may be said to be pathognomonic of the disease?

There are some investigators who think that heredity plays some part in the disease. Snell writes "a tendency almost appears to prevail in some families to the development of nystagmus. Thus 3 brothers working in a candle pit were affected; 2 brothers at least twice has been met with, and a father and son more than once."

Stassen thinks that hereditary influence create a certain predisposition to the disease.

Ohm says: "From my incomplete observations, numbers of families with deficient 'light sense' are predisposed to nystagmus." Again, "disturbance of dark adaptation and alcoholism have proved factors which predispose to nystagmus." In the report of the Miners' Nystagmus Committee to the Medical Research Council (1922) the subject was dismissed with the following words:-

"The influence, if any, cannot be great and probably acts through the transmission of occular defects."

An appeal was made to the Medical Officer of Health of the Rhondda/

Rhondda Valleys on this point, and in his reply he said that in the Rhondda Valley cases of defective vision in school children amounts to 5,000 out of 36,000, but "our statistics do not show any increase in defective vision among school children during the last 15 years."

Personally I do not think that there is any special or nystagmic defect congenitally transmitted from the parents; and as nystagmus attacks such a large percentage of the working population that one expects to find a certain number of cases among relatives. Again one also expects that cases would occur in families in accordance with the working of the general law of averages when sons and fathers follow the same occupation. The question that has exercised my mind is the possibility of a nervous diathesis being transmitted which under suitable conditions produces symptoms and signs of nystagmus. This may be the explanation of the occurrence of nystagmus in some young workmen who develop nystagmus signs and symptoms soon after entering the pit. From my records, the mean average years of underground life before the miner develops nystagmus is 29·3 years and Llewellyn gives it as 25·9 years, but it is interesting to note that 9·2% of my cases developed active nystagmus before they have had 10 years of underground experience, and one actually developed the malady under one year of toil. Under these circumstances it may be fair to assume that such cases have inherited a nervous system that is unsuitable and easily deranged by the affairs of the work, and so give rise to manifest nystagmus more early/

early in life than usual. It must be remembered that they work semi- darkness with many unusual sights and sounds, different entirely from daylight associations in other walks of life. The family history may not be quite clear, some of their parents may be suffering from alcoholic intemperance and some may have history of mental disorders. Two of the lads actually suffer from epilepsy (Case 1 and 12). Under such mal-hereditary circumstances, the young pit lad begins life as a collier boy ill-equipped for an arduous and prolonged contest against the inroads of disease and the vicissitude of his labours. He may be able to work for ten years in various capacities, but at about 24 years of age or less he begins to show signs and symptoms of nystagmus. Supposing there is predisposition in his case to the disease, but mental and physical and nervous ill-equipment have already played their part, inducing breakdown, the excitement attendant on underground work, as from falls of the roof and sides due to pressure, runaway horse trains, men shouting to their horses or giving warnings of danger, accidents, blasting and so forth, will detrimentally affect his already nervous temperament and possibly his endocrine system, producing deficient digestion, rapid heart action and eccentric circulation with deficient metabolism and malnutrition and so favouring the development of nystagmus in early life. By this "predisposition" I mean nothing beyond the endowment of degeneracy, more or less:

Case 12: T. H. Collier. Age 21. Certified on 6/3/24. Had 12 months rest and then sent to surface 23/3/25 where he remained. Nystagmus still present. Sister very hysterical at times. Father suffering from Parkinson's disease for years.

Case 1: T. G. Age 24. Collier. Certified on 10/4/19. Eyes known to be bad for 3 years marked Petit mal. Mother epileptic. Marked myopic astigmatism. Left district eventually.

Case 10: I. B. Age 19. Collier's boy. Certified 23/1/23. Worked with brother 2 years. Put on surface work 19/11/23. Was there until 9/2/25 when he had an epileptic seizure. Paid off by colliery management. Sister died of epilepsy at 14 years.

Effect of Alcohol.

Looking at the statistics for the period 1910-12 published in Alcohol (H.M.Stationery Office 1919) the comparative mortality of males aged 25-65 from (a) alcoholism and (b) Alcoholism and Liver Diseases taken together, one finds that the mortality amongst miners is about the same as that of the agriculturalist for both groups, but the miner gives a much lower figure than the dock labourer as follows:-

Occupation	(a)	(b)
Coal miner	3	13
Agriculturalist	3	11
Dock labourer	26	43

From this one may infer that the coal-miner is a much more sober man on a whole than the dock labourer. Though the incidence of drunkenness in these mining districts is about the same as that of Cardiff (Docks), the mining community must be regarded as a comparatively sober one, as from the nature of their work the miner can only indulge himself after the day's work is done and it is a well-known fact that convivial drinking is much less harmful than industrial drinking.

I do not think that alcohol is a factor in the incidence of the disease, as the majority of my cases are teetotalers, and also that alcoholism and its sequel are seldom seen in these districts. If alcohol is a factor, then why is it that from 1914 onwards, in spite of scarcity of beer and its low alcoholic content, the incidence of the disease has not shown any decline. From 1919 onwards, when wages started on the down grade and enforced a condition of temperance on the miner, the incidence of the disease has shown no decline, as one would expect if alcohol has any influence as a causal factor. The progressive plight of the liquor trade in these areas during the past 6 or 7 years is surely a measure of the enforced temperance of the community, and yet in spite of this, miners' nystagmus has been on the ascendance/

ascendance, as seen in the number certified per annum from 1919 onwards.

Ohm considers that alcoholism is a predisposing factor in the disease. In view of the fact that many confirmed drunkards have not developed nystagmus after 30 to 40 years of underground life and drinking, it is hard to believe that there is much connection between the two. It is a well-known fact that repeated bouts of drunkenness at short intervals, or a prolonged imhibition of alcohol extending over a week or more may easily convert a latent case into a manifest one, and here the part played by alcohol is no more than that resulting from a severe attack of influenza or from an accident. The following case illustrates my contention:-

Case 28: E. J. Age 32. Collier. Was a teetotaler. His undoing came when he made £50 from horse racing. Went away with a friend who crosses him in the afternoon shift. Had 3 weeks hectic holiday and drank a great deal. When the money was spent both returned to work. Within a week he had trouble with his eyes but not so his friend. He was not conscious of oscillation before. Worked on for three weeks and then had to give up on account of giddiness. He was certified on 13/6/22. He rested for four months and returned to his usual work underground on 3/10/23, though nystagmus was present. He managed till 4/12/24, drank moderately but failed to work and was recertified. In the recurrence he developed Blepharospasm./

Blepharospasm.

Since recertification, alcoholic habit developed progressively, and can always be found in a certain public house. He is negotiating with the colliery company to buy him out for a lump sum at present. Asked why he is always drinking he said that alcohol steadied his eyes and so intemperance.

Here we have two men working under exactly identical conditions, both had a good bout of drinking and yet only one developed nystagmus, and the other has no oscillation at all. That alcohol lengthens the period of incapacity is only too true. A man incapacitated by nystagmus has so much time on his hands that the temptation to drink is great. He is unable to do anything during the early stages and company is only to be found in public houses or clubs. In these places he has either to join in or be left out. He will find that alcohol steadies his eyes, and a false idea is gained, so lead to a sort of vicious cycle: nystagmus - enforced idleness - mental depression - alcohol - delayed recovery. The delayed recovery is seen especially in chronic alcoholics who have developed nystagmus. And it is in these cases that recovery is not only delayed but sometimes impossible so long as the habit continues.

The action of alcohol on the oscillation in these cases is seen in a series of six cases to whom alcohol was given on an empty stomach during one evening. Of these six men, four were teetotallers, two of whom were uncertified cases which may be regarded as latent, although oscillation is experienced/

experienced by them, but they are able to continue working; the other two were certified some six months ago, and have just been put on the surface to do light work. The remaining two were alcoholics, who had been incapacitated for some time. In all cases two ounces of whiskey were given. The presence of oscillation was demonstrated by the use of the ophthalmoscope, and checked by the same method after administration. The ability to read certain marked paragraphs of a newspaper was noted before and after administration in artificial light. In all cases there was an improvement in the eye condition as evidenced by their ability to pick up a newspaper from a couch, sit down, and read the paragraph aloud, a procedure not one of them was able to do before the administration of the whiskey.

The following were the cases tested:-

Latent Cases.

D.N., age 36. Collier, incapacitated through injury to knee giving rise to mobile internal meniscus three months. Had cartilage removed. Conscious of oscillation for some months but able to carry on, but unable to read the newspaper at night on account of apparent movement of objects. The general anaesthetic during the operation had not made his eyes worse. Oscillation much better now on account of rest. After the administration of whiskey he was able to read the paragraph splendidly, a thing he was unable to do the night before. Effect taking place in 28 minutes and lasted 1½ hours. On examination move-

ments/

ments are markedly diminished and eye steady. He was no worse the next morning.

W.T., age 28. Collier, conscious of oscillation since he had his mouth cleared of bad teeth. Useless to try to read at night after the day's work. Alcohol steadies the eyes in 20 minutes and he is able to read. Later he vomited and became very giddy and eyes became worse. No bad effects the next morning.

The next two cases have just resumed work on the surface after six months of idleness.

Case 31: O.T. Age 34. Repairer. Certified on 20/10/24. Resumed on the surface 21/4/25 with nystagmus present. Eyes became steady with alcohol in 25 minutes lasting two hours. Able to read during the day and after administration read well with artificial light. On examination eyes very steady. No effect in the morning.

Case 32: W.R.H. Age 45. Collier. Certified 22/10/24. Resumed on surface 21/4/25. Nystagmus present and giddiness if he turns round quickly. Alcohol steadied his eyes and can read the paragraph well. Unable to do so other nights. Effect takes place in 22 minutes and lasted 1¾ hours nearly.

The last two cases are seasoned drinkers. Wellknown members of a club. The action of alcohol on them have much the same characteristics as the other cases. They are chronic nystagmic cases who have been paid a lump sum by the management to be freed of all liability.

Case 36: R.E. Age 36. Haulier. Certified on 7/6/20. Fair hair of/

of fine physique. Vision normal. Has oscillation with some Blepharospasm. Been drinking since age of 16. He was out for 29 months and put on the surface on 27/11/22. He worked for a few days but complained of giddiness on looking upwards in the course of emptying a truck of long timbers. The management, after getting a good bit of trouble from him, put him on the unemployment exchange, as they had no suitable work for him to do, paying partial compensation. He was repeatedly examined and showed marked nystagmus. As there was very little chance of him recovering, he was given a lump sum, £80, in settlement of all claims, which was squandered in his usual way - drinking.
I asked him to describe the action of beer on him and this is what he said: "Two or three pints of beer in the evening steadies my eyes. I can read the newspaper and even play billiards, but if I drink too much I will not be able to see anything at all and have to be led home then. The next morning, after sleeping it off, my eyes will be bad until I have a pint or two again, and then I will feel as fit as a fiddle again." Perhaps the reason for his marked nystagmus on examination by the referee was engineered by himself the night before.

Case 37: J.G. Age 33. Collier. Certified 29/12/19. Rested for 39 months with no improvement and was bought out by the management for £90. "I used to drink two or three pints on Saturdays only, but became worse after I became bad. Beer helps my eyes, as after a couple of pints, I can read and play cards. I do not get drunk often and I limit myself to 4 pints a day." He auguments his income by selling rabbits obtained/

obtained from his brother's farm, without the knowledge of the Company, and he finally bought an interest in the farm in Pembrokeshire with his compensation money.

That a bout of drinking may upset the improvement gained after weeks of rest is seen in this case.

Case 33: F.C. Age 38. Collier. Certified on 19/2/23 with headache, giddiness and marked oscillation. His sister got married on the 1st of May and he had mixed alcoholic drinks far more than was good for him. He sent for me the next day and he was very giddy with marked oscillation of the eyeball and photophobia. He had an attack of acute gastric catarrh and was unable to stand, which cleared up in a few days. "My eyes would have been better by now if it had not been for that bout," he tells me. He was placed on the surface on 25/2/24 with nystagmus still present. Here is an improving case retarded by a single bout of drinking.

That a bout of drinking does not reproduce oscillation of the eye after it has disappeared is seen in these two cases. The fallacious idea that it does reproduce oscillation is seen amongst the miners who have recovered to undertake their usual work, but do not wish to do so, or amongst those who, if they returned to their usual following would find their income materially diminished.

Case 35: D.J. Age 39. Collier. Certified 11/5/22. Resumed to surface on 9/10/23. This man's wages were made up to his pre-affliction earning capacity while on the surface. After six months on the surface he was sent to the independent medical/

medical referee for examination. He got very drunk the day previously, but in spite of it he was certified as capable of returning to his usual work on 19/4/24.

Case 34: I.J.H. Age 35. Spragger. Certified 8/2/24. Giddiness and oscillation. His oscillation disappeared and he was certified as fit to return to his usual employment, but he contended that his sight was still bad. The case was brought to the independent referee, who decided against him. He had a bout of drinking before the examination but it produced no impression on his eyes.

Mine Gases.

That miners nystagmus is caused by intoxication due to mine gases was first enunciated by Schroter in 1871 and amplified by Rens, Pechdo and Manovrier, and by Robson of South Wales in 1923.

This theory is an attractive one because in those pits in which the light is most defective the percentage of gas is sure to be relatively high. The known gases that are found in the mine air are CO_1 CO_2 and CH_4. The question of CO_2 and even deficiency of oxygen as the possible cause of miners nystagmus can be dismissed instantly, as excess of CO_2 and deficiency of O_2 in mine atmosphere are met with much more often in open light pits, than in pits using safety lamps, and nystagmus is practically absent in open light pits. Again, owing to the increased barometric pressure, a miner has, under ordinary conditions, a better supply of O_2 in his lungs than a man above ground. Therefore the question of deficiency of O_2 can be dismissed.

That/

That methane or fire-damp in the mine atmosphere necessitating the use of safety lamps might be the cause of miners' nystagmus may also be dismissed if one considers the physiological effects of fire damp on man or animals. Methane is a physiologically inert gas, its presence in the atmosphere causes a deficiency of O_2 by dilution, and the breathing in of such a gas causes symptoms resulting from want of oxygen, and these are not directly due to the action of methane. T. Lister Llewellyn in furthering the certainty on the point, made a mixture of 80% of oxygen. He kept a mouse in it for a considerable time quite unaffected in any way. Breathing the mixture himself for a few minutes he could not distinguish it from ordinary air and no abnormal symptoms were produced.

That the chief delinquent of contributory gaseous agents in the production of miners' nystagmus is carbon monoxide, has lately been put forward by Dr. Robson of South Wales. He contends that in comparing coal miners' nystagmus with coke burners' nystagmus due to carbon monoxide, that there is a great similarity of symptoms and signs referable to each other "while engaged officially in South Wales and Monmouthshire coalfields, the writer (Robson) was surprised to find considerable differences in the numbers of men suffering from nystagmus in the respective division - reason unknown. The apparent increase was most evident in Monmouthshire, and was especially noticeable when the men emerged from the pits in daylight. The differences in numbers attacked in three respective parts of the coalfields were very puzzling as to possible cause/

cause, and further investigation was considered advisable. From subsequent knowledge obtained, difference in coal composition disclosed the evidence of varying chemical and volatile percentages in the geographical distribution of seams." Later evidence obtained from Dr. Galloway indicated that "the change in the quality of the coal, from high bituminous in the South-east to anthracite in the North-west of the coalfield is gradual and continuous, and extends to every seam. The best steam coals are in the intermediate stage.

1. S.E. Bituminous Volatile matter approximately 30%
2. M. Steam " " " 16%
3. N.W. Anthracite " " " 5%,

with every intermediate percentage.

The upper seams everywhere contain more volatile matter than the lower seams."

Therefore on Dr. Robson's hypothesis, No.1 should give rise to double the number of cases of nystagmus compared with No.2, and six times more than No.3.

The South Wales and Monmouthshire coalfields are divided for commercial designation and usages into the following areas:

1. Monmouthshire
2. Glamorgan East
3. Glamorgan West
4. Carmarthenshire.

Under his contention that differences in percentage of volatile contents of coal is a possible cause of differences in/

in prevalence of the disease, Dr. Robson attempted to establish his proof by the following table:

		V.%		%	
1.	Monmouthshire	29.50	gave	4.57)	Nystagmus in men
2.	Glamorgan East	21.19	"	2.22)	employed below
3.	Glamorgan West	15.50	"	1.90)	ground basis from
4.	Carmarthenshire	11.87	"	1.15)	1909 to 1919.

There is therefore more nystagmus in Monmouthshire than in Glamorganshire and more in Glamorgan East than in Glamorgan West per number of men employed.

In the artificial division of the coal field, the seams are not exactly alike chemically, nor have they a similar C/H ratio nor volatile percentages, e.g. the coal in the northern part of Monmouthshire are harder (tend to be carbonacious in compound) than the coal in the southern part of Monmouthshire. Some of the seams past westward and in doing so they are subjected to debituminsation processes, and the coal becomes harder. This process is progressive and terminates in the North West area in the formation of the hardest coal (anthracite). This process is not confined to from East to West, but also takes place in several other directions, as for instance from South to North. Therefore from East to West and from South to North, the coal increases in hardness and decreases in volatile content, the former is represented by an increase in C/H ratio, and the latter by its percentage reduction. C/H ratio means the percentage of carbon to hydrogen calculated on pure coal and the relative proportion of C to H is the C/H ratio or/

or degree of anthracitation of coal. The percentage of carbon in coal determines the type of coal - viz. Anthracite, carbonaceous, bituminous, lignitous.

The volatile matter in coal varies with the percentage of hydrogen contained, the greater the hydrogen percentage, the greater the volatility. Coal may be classified as follows:

Coal below 17 C/H = House coal
" between 17 & 20 C/H = Coal passing from house to steam
" " 20 & 30 C/H = Hard steam coal
" above 23 & up to 24 C/H = Anthracite coal

In county or area divisions of the coalfield, it is found that dissimilar analytical coal characteristics were determined not only by their topographical distribution, but also that similar changes occur in the seams stratigraphically in the sequence of their geological graduation from above downwards, i.e. from the upper to lower measures in all areas. This latter statement is proved by Dr. Gillingworth who classified the seams from above downwards as follows with percentage volatile values:-

From upper to lower measures.

Llanwit or upper measures Volatility 37-40% approx.
Pannantgrists or Middle " " 19-37% "
Shale or Lower " " 5-20% "

These percentages are slightly higher than those given by Dr. Galloway for horizontal lines across the coal field (Table 1 quoted by Dr. Robson)

It is also true coal merge and grade into each other, and in/

in doing so may change their chemical constituent proportions and volatile content from one kind of coal to another, and therefore change their commercial usages also.

"The exchange of seam characteristics make for a statistical complex in the incidence of nystagmus found upon analysis and volatile content of coal which is the basic hypothesis of this paper. Correlating the seams with statistical findings generally (and not in coal owners' sections) the percentage ratios of nystagmus to number of men employed decreases from East to West. It is in this direction that volatile matter decreases and/or from South to North. In each direction the coal suffers from debituminisation processes. A parallel exists in nystagmus numbers from soft to hard coal changes from Monmonthshire to Glamorgan East and to a less extent from Glamorgan East to Carmarthenshire."

He contends that in estimating the relative percentages of nystagmus to volatile content of the measures, a fictitious bias is given to statistics owing to the lack of homogeneity in these coal seams. On the other hand, if soft coal seams progressed into the anthracite coalfield without intermingling of seams of varying volatile percentages, the statistics would not be subject to such an influence, and show by graph a steady decline in nystagmus to the full percentage relation of volatile content; but even the occurrence of sperodic appearance of soft coal seams amongst hard seams does not invalidate the relation of nystagmus to volatile matter, as found statistically. If representative groups/

groups of collieries in each division were taken, then the percentage parallelism to coal volatile percentage would be more than established in incidence of nystagmus.

"It will be observed that the percentage volatile content in Monmouthshire is nearly twice that of Glamorganshire as a whole county and the percentage of nystagmus is more than doubled. This fact is clearly evidence of the hypothesis of nystagmus being in some relation to volatile percentage in coal." (Robson)

According to Dr. Robson, it is in the bituminous areas of the coal field, viz. East, South East and along the South crop that a high percentage incidence of nystagmus arises. In these areas the pillars and stall methods of coal getting are more generally adopted than the long wall system, and he says that it seems reasonable to suppose that there would be less fresh air supply in pillar and stall workings, and therefore more gaseous mine contamination in these confined workings; i.e. more poisonous products retained through difficulty in rapid ventilation, and also more gaseous products because of additional gases due to oxidation of very fine particles of coal dust. He says that the coal itself appears to be the chief agent in the formation of carbon monoxide, which is possibly liberated in cutting at the coal face, and in oxidation of standing coal not removed from the pit the same day as it was cut. In support of his theory, he states that if temporary lapses takes place from time to time in power houses worked with producer gas from gas inhalation, and giddiness, headache, malaise etc., follow each day's work in a power house. A fireman/

fireman, not suffering from nystagmus in 1918 was subjected to large doses of gas and soon developed nystagmus and general nerve disturbances were exhibited, viz. rapid heart, increased reflexes, nausea, vomiting, malaise, insomnia, headaches, etc., oscillation of eyeballs and blepharospasm.

All the statistical facts that Dr. Robson has put forward are in the three following tables, and he stands or falls by these tables.

Table A.

1.	South East	Bituminous	Coal.	vol matter	approx.	30%
2.	Middle	Steam	"	"	"	16%
3.	North West	Anthracite	"	"	"	5%

This volatility of coal in the three districts into which Dr. Robson has divided the South Wales coalfield is given roughly 6, 3 and 1 for South East, Middle and North West. The percentage of volatile matter respectively 30, 16, 5.

Table B.

	Vol %		%	
1. Monmouthshire	29.50	gave	4.57)	Nystagmus on men
2. Glamorgan East	21.19	"	2.22)	employed below
3. Glamorgan West	15.50	"	1.90)	ground basis from
4. Carmarthenshire	11.87	"	1.15)	1909 to 1919.

Dr. Robson says No. 1 should, in my hypothesis, give rise to double number of cases of nystagmus compared with No. 2 and six times more than No. 3.

Table C.

This I have converted into percentages so as to facilitate comparison./

Percentage Incidence of Miners.

Nystagmus in South Wales Coalfields.

Area	West	Mid. Glam.	East
Year 1909	0·12	0·09	0·33
1914	0·21	0·23	0·33
1919	0·17	0·32	0·35

Volatility of Coal.

Table A.	1	3	6
Percentage volatility	15·50	21·19	29·50

Dr. Robson's statistical information is based on the number of claims for compensation since the disease was included in the Workmen's Compensation Act of 1906, on May 22nd, 1907. Can statistics be relied upon? I think that in any statistical enquiry into the incidence of incapacity caused by miners' nystagmus, the influence of the W.C.A. ought to be taken into account. When a disease is first scheduled it takes a few years before claims reach a steady annual level. This phenomenon is seen in the claims for beat knee, the incidence rate of which in Great Britain was 0·66 per 1,000 in 1908 and did not become steady until it reached 1·59 per 1,000 in 1911. Therefore taking beat knee as an example one ought to learn that compensation claims previous to 1911-12 did not give any useful measure of the prevalence of the disease. In 1913, the designation of the disease in the schedule was altered in such a way as to admit for compensation, psychopathic manifestations of the disease, as a steady annual level was again upset. After this a rise in the number of cases followed; but abroad, where no such alteration occurred, the claims for/

for nystagmus showed no marked tendency to rise. After 1913, we were dealing with a new statistical entity, and several years had to be allowed to elapse before a new level was established. Long ere this, the war intervened with its disturbance of the mining personnel; and when statistical information was again available in 1919, wage conditions were abnormal. By this time, the new designation in the schedule should have had full effect, but high wages would be acting as a deterrent to claims for psychopathic symptoms. On 1st January, 1920, a rise of compensation pay from 25/- to 35/- took place, succeeded by a sharp fall in wages in 1921, and so the attainment of a steady annual level was upset again.

It is a wellknown fact from the examination of large numbers of underground workers by various authorities that well over 50% had oscillation of the eyeballs without being in any way aware of the fact, and it is also a wellknown fact that claims for compensation vary with economic conditions; here we have evidence of a deep pool from which cases could rise to the fly of compensation. The number that rose was no sure proof that the number of fish in the pool was increasing or diminishing, but the more tempting the fly, the more cases would rise.

It is true that the incidence of certified nystagmus cases fall from east to west and that the coal gradually loses its bituminous character in the same direction, but there are pits in/

in the North-West area in which the incidence is higher than in many parts of Monmouthshire. Again we see adjoining valleys in the Eastern area showing a greater variation than that which exists between extreme West and East. For example, it is difficult to explain by Dr. Robson's theory, the great variation in the incidence of the disease in the three valleys of which Tredegar is the centre, Rhumney Valley to the West gives more than ·75%, Tredegar Valley in the centre gives more than 2%, and Ebbu Vale to the East gives less than ·50%. In these valleys the geological conditions and the men are the same, and the three great companies which control these valleys are surely a guarantee that the most up-to-date methods of work are employed.

Dr. Robson says that the coal itself appears to be the chief agent in the formation of CO, which is possibly liberated in cutting at the coal face, and in oxidation of standing coal not removed from the pit the same day as it was cut. To support his idea of oxidation of fine coal dust he quotes Dr. Illingworth, who states that "coal of the bituminous order gives rise to dust at the face by geological attrition, which oxidises readily at pit temperature with the formation of CO." An appeal on the question of production of CO in coal mines was made to Dr. Graham, and he states that as far as his experience goes, CO is not present in appreciable quantities in normal firedamp. In an odd case when we have found CO in gas issuing from a borehole there was evidence that such was produced by oxidation of some fine coal left in the borehole/

borehole. Recent samples taken in South Wales, have confirmed the absence of CO in ordinary 'gas' (firedamp). There does not seem to me to be any connection between the gas evolved from freshly won coal or from a freshly exposed coal face, and the gases evolved (oxides of carbon) as a result of the oxidation of coal. The former is due to gas already generated and retained by the coal in the absorbed condition (unexplained yet) and the latter as a result of chemical action of oxygen on some part or parts of the coal conglomerulate, with the formation of oxidation products, and at ordinary mine temperatures the liberation of CO_2 in small and CO in still smaller quantities. When the temperature of the coal is raised, e.g. in the vicinity of a gob fire, there gases are given off to a greater degree (compared with O_2 absorbed).

In Trans. Inst. Min. Engineers 1917 - 18, the composition of black damp produced solely as a result of oxidation of coal is as follows:-

N	94 - 94·5%	Black damp.
CO_2	5·0%	
CO	1·0 - 1·5%	

P. Mahler found quantities up to 0·002% in the return air of Frenk coal mines.

Dr. J. S. Haldane, F.R.S., says that no coal is volatile at ordinary temperatures. He discovered very small amounts of CO in the mine air some 25 years ago, which was formed at ordinary temperatures when air acts upon fresh coal. The proportion present is/

is seldom over 0·005%. He has never found any CO in the fire damp given off at ordinary mine temperature.

Has such a small quantity of CO in the mine atmosphere any appreciable physiological action on the human organism?

It is said that the body of an adult man of average weight contains enough haemoglobin to hold about 600 c.c. of oxygen. If completely saturated it would hold the same amount of CO, one molecule of CO replacing one molecule of oxygen in the blood. The absorption of 6 c.c. of CO into the lung then produces 1% satuation and abolishes 1% of oxygen capacity.

The unit, in which various concentrations of CO are commonly measured and expressed for purposes of ventilation, is one 'part' or a certain number of 'parts' of this gas mixed with 10,000 parts of air. A 'part' is 1/100 of 1% of the atmosphere.

The amount of CO that is absorbed by a man depends on the length of exposure, and even if the exposure is prolonged, CO merely displaces oxygen from the blood up to a point of equilibrium depending upon the relative amounts, or mass action, of CO and oxygen in the air breathed, and the intensity of the affinities of the two gases for haemoglobin. Haemoglobin attracts CO about 300 times as strongly as it does O_2 and according to Dr. Douglas 240 times. If hereafter the pressure of oxygen is high enough and that of CO is low, or absent as in pure air, oxygen can likewise displace CO and thus completely restore the oxygen carrying power of the haemoglobin.

Dr. Haldane contends that such a small amount of CO (·005%) in/

in mine air, can have no physicological action. Against this we have the experiment of Mr. A. P. Veale (vide Colliery Guardian 1922) quoted by Dr. Robson. Mr. Veale experimented upon himself in an air-tight chamber of 9·875 litres capacity and used a suitable "two-way" mouthpiece and bag. The air in the chamber was freely mixed with carbon monoxide and measured volumes of this air containing CO were examined in inspiration and expiration by means of Ivor Graham's apparatus. The difference in measurement in the two respiratory processes indicated the amount of CO retained or absorbed in the system. Experiment No.1, at rest, resulted in CO inhaled in litres per minute of 0·014 and exhaled 0·007 per minute. The proportion absorbed equalled 50% during quiet respiration at 17 per minute. "This absorption of CO for a short time gave direct evidence of physiological disturbances, some of which were similar to those found in nystagmus patients suffering from subjective sensations of the ailment. The amount absorbed into the system was 0·007%. It is reasonable to suppose that inhalation of such small amounts of CO as ·005% carried on for prolonged periods as in daily contact with the gas, would bring into evidence a large range of morbid defects, and possibly those of oscillation of the eyeball (nystagmus). These excursions of CO into and out of the system have left some depressed or exalted function of controlling nervous or brain cells."

Is CO a cumulative poison?

Drs. Glaister and Logan, 1921: "when CO as a constituent of abnormal air is inhaled, it expels the oxygen from the haemoglobin to/

to form a more fixed combination, but respiration of fresh air causes it to be dissociated and to be expelled from the blood, the haemoglobin being thus enabled again to unite with the oxygen (of the air). In persons who have died of CO poisoning, after 5 to 6 hours no CO was found in the blood. The question to decide is, what is the role played by CO poisoning? One school believes that poisoning is due to anoxaemia, the other school believes that poisoning and death are due to some specific action of the gas on the nervous system, and not to oxygen starvation. Some observers declare that CO gas exercises a specific action upon the central nervous system through the circulating blood which carries it thither.

Dr. Haldane conclusively shows that CO acts solely by combining with haemoglobin and in no other way: firstly, by placing animals in oxygen at a pressure of two atmospheres, the blood takes up in simple solution sufficient oxygen as to render the animal independent of its red blood cells as oxygen carrier; CO at a pressure of one atmosphere is then added; under these conditions the intoxication of CO is abolished, although the haemoglobin of the animal may become saturated with it. Secondly, by placing in an atmosphere of 75% of CO and 25% of O_2 animals which have no haemoglobin, such animals are unaffected.

These experiments of Dr. Haldane are conclusive, and have proved that CO is a physiologically inert and non-poisonous substance, and that the results of its inhalation are due directly or indirectly to oxygen deficiency. It acts wholly through asphyxia/

asphyxia, although the affinity of O_2 for haemoglobin is much less than that of CO, still the presence of O_2 in the respired air exercises a certain inhibitory influence on the formation of carboxy haemoglobin. There is a maximum limit to the extent to which the haemoglobin can become saturated with CO when a small percentage (0·005%) is present in the air breathed; the system does not accumulate CO to an indefinite extent; this maximum limit is far too low in the case of the air normally breathed by minors to cause any appreciable physiological effects. Moreover, any CO absorbed is given off again when pure air is breathed. Owing to the increased barometric pressure a miner has, under ordinary working conditions, a better supply of oxygen in his lungs than a man above ground. This is still the case if the maximum percentage of fire damp or black damp allowed by the Mines Act, is present in the atmosphere. This latter condition will nullify the contention that deficiency in the oxygen percentage may be the cause of nystagmus of miners. The more O_2 a miner has in his lungs, the quicker will be the dissociation of carboxyhaemoglobin when formed.

If CO produced by oxidation of fresh coal could produce appreciable effects on men, then miners must be working under conditions of extremely bad ventilation. Such does not exist in the working places of any modern British coal mine, and would if it did exist, constitute a gross breach of the Mines Act. If coal miners are subjected to chronic CO poisoning, then the occupation must be an unhealthy one, and yet the death rate amongst/

amongst the mining community is only equal to that of agricultural labourers, excluding fatal accidents. An appeal made to the various classes of workers in the area, from general managers down to boys, elicited the fact that the ventilation is very satisfactory and very much better than in years gone by.

All is subjected to the influence of chronic CO poisoning, if any, yet 50% of the men can work in the coal mine without showing any resultant effect. Are these men immune against CO poisoning and is there such a thing as immunity to carbon monoxide poisoning? If CO is an accumulative poison, is the accumulation progressive? If so, then all the latent cases will at some time or other in their working life come under the Compensation Act. This is not the case as many men who have retired after 50 years underground without nystagmus and have never received a penny compensation money.

If it is a case of chronic CO poisoning, it will be very difficult to explain the following cases which were certified after the three months' strike in the year 1921. In my records the year 1921 produced 14 cases. Five of them were certified 2 months after the strike. Surely the three months rest in the open air ought to have benefited these cases, yet almost on resumption of work these people have trouble with their eyes.

Case 27. T. E. Age 52. Collier. Restarted after the 3 months strike on September 12th. Within a week his eyes became worse although he was conscious of oscillation for some months. He said He/

he improved during the holidays, but now much worse. Certified 4/11/21. Resumed underground 22/7/23 but on light employment with nystagmus present.

If a chronic variety of carbon monoxide poisoning produces miners' nystagmus, how is it that we never see a case of miners' nystagmus in those who work for gas and coke companies? All of these people are equally if not more frequently exposed to CO than are CO miners. Lastly, the irregular to and from movement of the eyes in acute CO poisoning from producer and illuminant gas is not comparable to the fine rotatory rhythmical oscillation of the eyeball seen in nystagmus.

Dr. Robson has pointed out that on the South Wales coalfield the cases were far higher on the bituminous East than on the anthracite West; but he omitted to mention that locked lamps, giving low illumination, had long been prevalent in the East on account of explosion danger, while naked lights, giving greater illumination, were still in use in the West where the explosion danger was small. So long as safety lamps gave less light than naked lights, there must be close correlation between gas in workings and low illumination. This correlation would support either the theory that nystagmus was due to dim light or that it was due to gas.

The general consensus of opinion is against the Gas Theory. Dr. Haldane, M.D.,F.R.S., in the Report of the Miners' Nystagmus Committee (1922) to the Medical Research Council says:-
"We may therefore conclude with complete certainty that the abnormal/

normal constituents in ordinary mine air have nothing whatsoever to do with the production of miners' nystagmus."

Pathology of Nystagmus.

The first point that impresses an investigator into the causes of nystagmus is the fact that many observers of nystagmus have seen fit to proclaim their theories as complete when they were simply advancing evidence to prove that certain predisposing conditions were essential to the production of nystagmus. Here, of course, one refers to the majority of the writers on miners' nystagmus.

One is often struck with the unanimity with which other writers of wide medical experience have followed the lead of those whose interest lay solely in miners' nystagmus, and have agreed that this variety must not be classified with the ordinary forms of nystagmus, or be regarded as explicable by the current theories.

W. G. Sym, in the article on "Ocular Muscles" in the Encyclopedia Medica, writes: "From the muscular point of view, we have principal varieties to deal with, miners' nystagmus, paretic muscle nystagmus, and that connected with spinal and cerebellar lesions."

W. Osler, in his "Principles and Practice of Medicine", discussing nystagmus in four lines says: "The condition is met with in many congenital and acquired brain lesions, in albinism, and sometimes in coal miners."

May and Worth, in their book on Diseases of the Eye, writing on/

on nystagmus in general, say: "It is also found in coal miners (miners' nystagmus). In these cases it is probably due to working in a recumbent position with the eyes turned upwards and obliquely."

Herman Willbrand, M.D., after discussing the relation of nystagmus to the general equilibration of the body, goes off at a tangent and says he regards miners' nystagmus as "'a paresis' of the elevators and a concentric contraction of the visual field."

In attempting to find a common cause for a symptom occurring in conditions so widely diverse as syringo-myelia and coal-getters' labrynthine disease and ether anaesthesia, congenital cataract and alcoholism, the first work is to classify any known facts or observations on gross pathological lesions which have been in any of the conditions giving rise to nystagmus.

The links in the pathological chains are:-

1. The Eye as an optical instrument.
2. The muscles of the eyeball.
3. The source of their innervation.
4. Extrinsic stimuli which affect it.

1. <u>The Eye</u> as an optical instrument, plays its part in the causation of nystagmus in congenital and infantile cases and in some cases of total blindness occurring in adult life. That is to say, the patient has never had proper vision, or has had it and lost it.

For the production in infancy, it is necessary that there should have been some influence at work which has prevented the formation/

formation upon either macula of images which are clearer or more capable of accurate perception than those formed on other parts of the retina. The differentiation of retinal perception takes place very early in life, probably not later than the first few weeks, after which the child learns that by "fixing" the macula upon the object of vision, it gets a much clearer image. No doubt the differentiation, at this stage, is extremely slight, yet the mere fact of fixation means that already the macula is not merely potentially but actually the most acutely perceptive point of the retina, and already the "centre" has been educated to direct the eyeballs in such a position that the image may fall on the spots.

As already stated, the condition which may prevent the formation of superior macular images (which in addition to being early, must be bilateral) may be in the nature of a retrobulbar inflammation of the optic nerve, possibly so light as to involve only the atrophy of the central fibres (which come from the fovea centralis), or a choroid-retinitis involving the macula; or severe congenital cataracts, or corneal opacities, the result of ophthalmia neonatorium. In the adult, the total loss of the projection of light is an essential, except in albinos where there is a congenital reduction of acuity of vision, frequently combined with a high degree of myopia, both of which causes operate against the formation of a "superior" macular image.

Having noticed that the intrinsic obstruction to clear vision/

vision is an essential to the causation of infantile or congenital nystagmus, it is but a step further to enquire as to the condition of illumination which obtained in the cases of nystagmus acquired in adult life, especially in coal miners' nystagmus.

The following dates should be noted:-

Miners' nystagmus was first described in 1861.

Safety lamps were introduced into many mines in 1850.

What is the difference between the safety lamp and its predecessors?

Previous to the introduction of the Davy lamp into the mines, the work was carried on by candle and flare light, and as "candle power" is a standard, and candles are not all standard, the following figures are necessary to a clear conception of the illuminating powers of various lighting agents:-

A standard candle burns 120 grains of sperm every hour and is said to be of one candle power ..... 1 C.P.
Tallow candles (16 to the pound) ..... 0.69 C.P.
Tallow candles (18 to the pound) ..... 0.55 C.P.
From this one gathers that the average candle is not much more than half the standard candle power.

The primitive Davy lamp consists of an oil reservoir and a gauze cylinder enclosing the flame, and the illuminating power was about 0.28 C.P. This safety lamp has passed through many modifications up to the present day. The three main parts are the oil reservoir, the glass cylinder surrounding the flame, and/

and the gauze with its protecting metal bonnet. In later years the modifications have been the introduction of the double gauze, improvements in the arrangement for lighting and locking, and the use of a more volatile oil. The introduction of the Wolf naphtha lamp was a great step forward; it gives 0.8 C.P. but has now fallen into disuse. Up to the year 1910 most attention had been paid to the safety of the lamp, its illuminating power being delegated to a place of secondary importance. The offer of a £1,000 prize in an international competition in 1910 has brought the electric lamp to the front. The great difficulty of obtaining a reliable accumulator was then overcome, and nowadays the modern safety lamp has given place to the electric pattern, while the former oil lamp is chiefly used for gas-testing, and also in workings where there is fear of gas being present, in which case the miner is usually supplied with an electric as well as an oil lamp.

In this district, electric lamps were introduced in 1914.

The illuminating power of the various safety lamps are given as follows by Llewellyn:-

Kind of Lamp.	C.P.
Cambrian fireman's (like a Davy)	.165
Cambrian (Thomas and Williams)	
Old Type	.235 to .27
Newer Type	.35
Latest Type	.4
New Lamp	.65
Ackroyd and Best	.4

Patterson/

Patterson	.42
Wolf (little used)	.8
Fevat primary electric lamp	.9
Gape " "	.6
C. E. A. G. lamp	.8

This lamp won the first prize of £600 in the £1,000 International competition for the best miners' electric lamp by F. Foeber in 1912.

Oldhams Hewer's shadowless lamp 1.2 C.P.

There has been a great improvement of late years in the candle power of the lamps, and a candle power of 2 has been attained; but the candle power claimed by the makers is rarely found in practice. The latest C. E. A. G. pillarless lamp with reflector claims to give 2.4 C.P. of reflected light (1927).

In the case of safety lamps, these figures are true only when the lamps are clean, not when coal dust has accumulated on the lamp glasses, under which condition the candle power falls by 25%. Again the naked candle illuminates evenly in all directions, except downwards, whilst the safety lamp casts deep shadows upwards from its bonnet, downwards from its base, and slight shadows from its framework at each corner; and while the candle can be fixed anywhere to suit the miner, the lamp by the regulations of the Coal Mines Act, must not be within the reach of the swing of the pick. Also the light from a candle is constant, whereas the safety lamp loses its 1.P. as time goes on.

So/

So that from all these standpoints the safety lamps of later years must be regarded as inferior to the old-fashioned candles, torch or flare light. The latter gives as much as 2 to 3 C.P. The electric lamps used in the pits where I make my observations are the Oldham Hewer's Lamps which give a candle power of 1.2, and compared with a standard candle, the illuminating power of the former is not much better than that of the latter, but is much more superior than the best oil patterns, which give about .65 C.P. Although in late years the quantity of light has improved, the amount of light reaching the colliers' eyes is still insufficient, and still below that of pre-safety days. It is true that a candle power of 2 in lamps has been attained lately, but how many collieries have adopted them, as it is a costly item running into thousands of pounds?

The illumination at the coal face depends on various factors, and it may be advisable to look into them.

1. Candle power of Lamps used.

The candle power claimed by the manufacturers is not always found in practice, as the light is split up in the horizontal plane by the standards, and there is also a variation in the vertical plane and extensive shadows are cast by the bonnet and reservoir of the lamp. The position of the filament or flame, whether it is end on or broadside, also causes variation in the candle power. The quality of bulb may/

may also cause variation, one set may give better light than another. The falling off in candle power of lamps as the day progresses makes for a variation.

2. The distance of the source of light from the working area is of great importance, as the intensity of illumination varies inversely with the square of the distance of the source of light; thus 1 candle at 1 foot, 4 candles at 2 feet, 9 candles at 3 feet, all give equal illumination. A candle can always be placed nearer the coal face than a safety lamp, and in many cases is only 12 to 18 inches away. There is always a strong tendency to leave the lamp in the same position too long, and on a visit to the working places underground, I have seen men working nearly 6 to 8 feet from their lamp, and their body and swinging pick obstructs the light.

3. Surface Brightness. In a confined space illumination is dependent upon the reflection from the containing boundaries. This is best illustrated by the explanation of Trotter of the great importance of this reflecting power. "If lights amounting to 100 C.P. are placed in a room having walls, floor and ceiling of a reflecting power of 80%, 1/5 of the light will be absorbed and 4/5 reflected. This reflected light is for all intents and purposes a new light of 80 candle power. The total effective light in the room is therefore the same as if the walls and ceiling are black and 400 lamps of 1 C.P. each are spread evenly over the walls, in addition to the original 100 candle power." This diffuse reflecting power is practically absent/

absent at the coal face, for the coal itself is black, the floor covered with coal and coal dust; the roof is in darkness owing to the shadow cast by the bonnet. Therefore the miner working at the coal face is surrounded by non-reflecting surfaces and the average illumination is very low, only equal to about 0.018 to 0.09 foot candle (LLewellyn).

An interesting experiment was carried out by the Departmental Committee on Lighting in 1915 to determine the smallest amount of illumination which would enable a seamstress to work with black velvet, which absorbs 97% of all incident light without experiencing discomfort. The amount found was 4 foot candles, and, contrasted with this finding, the miner at the coal face has a very low illumination indeed.

There is great diversity amongst observers as to the place occupied in the causation of nystagmus by insufficient illumination, the two extreme positions being taken up by Court on the one hand and Snell on the other.

Court Senior of Staveley, Derbyshire, specially investigated the question of the comparative influence of naked lights and safety lamps (the naked light being the stronger illuminant), and the following figures are briefly abstracted from his pamphlet, published by the Derbyshire Miners' Union in 1891.

No. of men working with safety lamps	524
No. of cases of nystagmus	164
No. of men working with torch light	231
No. of cases of nystagmus who had always used torch	0

No. of men working with candles	342
No. of men suffering from nystagmus who have always used candles	3
No. of men suffering from nystagmus who had previously used safety lamps	23

Note that all the above cases were following their employment.

These figures show a striking preponderance in the percentage of cases of nystagmus in "safety lamp" mines as against "candle" mines, and represent the extreme view which ignores every other factor but that of faulty illumination. Thus Court maintains that insufficient light of the safety lamp is the chief, if not the sole cause of nystagmus, and that position has very little, if anything, to do with it. With Snell's writing in view he goes on to say: "If the cause of nystagmus be, as Snell says, the position of the head and eyes directed upwards during the process of holing, how is it that, in naked light mines where the work of holing is done exactly in the same way as in safety lamp pits, there is comparatively no disease at all? The statement, moreover, that the miners have their head and eyes directed obliquely upwards during the process of holing is contrary to fact." Further than this Court does not go; having proved that a very feeble light is a factor of prime importance, he leaves the causa causans to be sought for.

This view, as I have previously stated, is accepted "in toto" by the miners themselves. "It is the lamps that does it."

On/

On the other hand, Snell, especially in his early work which was slightly modified later on, is disposed to regard the faulty illumination as a very minor element in the disease. It has to be admitted that he produces no such definite figures as Court does. "Imperfect illumination does indeed occupy only a secondary position in the production of the disorder ..... other things being equal, nystagmus will be more frequent with the less perfect illumination. I am bound to say, however, that the relatively large number I found off work at the naked-light mine was more than I was prepared for."

Tathun Thompson brings forward interesting evidence of somewhat the same nature from South Wales. In the mines he refers to are two kinds of coal: (a) house coal in thin seams worked by naked lights by holing; (b) steam coal in thick seams worked by feebler safety lamps, by straight work, without holing. Nystagmus is much more common in those who work the steam coal. In summing up he says: "I would submit that visual strain, with insufficient illumination, is at any rate as great a factor in the causation as strain of the ocular muscles."

Nuel states: "The frequency of nystagmus varies in inverse ratio to the illumination of the mines."

Harrison Bulter says: "There is no doubt that nystagmus is far more common in safety mines than in candle mines."

Roimee (of Liege) says that the incidence of miners' nystagmus in Belgium where the Muesster's lamp (.44 C.P.) is used, is much greater than in Germany where the Westphalian lamp/

lamp (.66 C.P.) is used, and mentions that where the Wolf Benzine lamp (.87 C.P.) has been introduced into a mine, the case incidence of nystagmus has fallen to 50%.

This is not the experience in this country, for in spite of improved illumination the case incidence has not diminished. In 1914 the electric lamp was introduced into the pits, and from then onwards the incidence rate has fallen from 0.4 per 100 men employed underground to 0.26 per 100 men underground in 1917. From 1917 onwards nystagmus has progressively increased in spite of a better light and increasing replacement of oil lamps. The increase may be largely due to the attention called to the disease, to the increase in knowledge of the disease and resulting improvement of diagnosis, and probably also due to accumulation of long-standing cases, as it used to be taught that cases of nystagmus should not return to underground work even if they have recovered. The disease then, may be said to have increased in the same way as appendicitis has increased in the last 20 years.

The experimental evidence furnished by Ohm may be said to be conclusive to the relationship of nystagmic genesis to deficient light. He shut up 3 puppies and 2 kittens in a dark cellar, and found nystagmus in all the animals after an interval varying from 10 to 48 days. He was able to take tracings of the ocular movements and found that they resembled those obtained from miners suffering from the disease.

The great advantages of a candle over a safety lamp have led/

led T. Lister Llewellyn (Colliery Guardian 1912) to the conclusion that: "Taking all these factors into consideration, we may say that the collier in a naked-light pit works in an illumination five to ten times as great as that obtaining in a safety-lamp mine." The discrepancy is not so great nowadays on account of the general introduction of electric lamps, and the improvement in candle power lately achieved.

Now consider the miner working in a dim and an unnatural light practically all his working life. Physiologists tell us, that in this feeble light, he sees not with his cones but with his rods, and these are greatly diminished in quantity at the macula so that the visual acuity of the rods is at a maximum in a retinal band surrounding the fovea at a distance of from 15° to 20° from it. In this annular ring the visual acuity is practically everywhere of the same value. In a good light we fix with the fovea, but in the poor light of the mine (G.I. 0.018 to 0.09 C.P.) the miner can fix at any point on this prefoveal ring, he has no retinal directing point, and the necessity for central fixation is absent. This appears to be quite analogous to the infantile cases of nystagmus arising before the specialization of the macula. As rods are provided for peripheral vision and for use in dull light occasionally, the miner working in an unnatural light practically all his working life, is not equipped for this, as animals which live under similar conditions are, e.g., the owl, mole, bat, etc. The latter have rods only, and closely aggregated rods, physiologically/

physiologically speaking, are of use for perception purposes when images are moving over them and stimulating several successively. They are slower in response and in keenness of perception than the cones, which are of later and higher development. Hence we find them in use by animals who move about whilst they view an object, or vice versa, whilst stationary they view moving objects, as in peripheral vision of man. An owl will move his head in an oscillatory manner if food is held in front of him in daylight, otherwise he cannot see it. The man who works below ground in the dark or dull light and who wishes to see clearly or to approach to his natural vision in light, must use his rods; his cones no longer function. In order to use his rods for vision, he must have the object viewed in motion and rapid motion over several rods. If the object cannot move, the eyes must move, each in symmetrical relation to the other and in the perimacular region where the rods are most thickly aggregated; hence the oscillating movement commences as a physiological effort to see. From much repetition the supranuclear centre of the oculo-motor nerves develop a new reflex action, which continues when the miner comes to the surface.

2. The Muscles of the Eyeballs.

Around the six muscles of the eyeball has waged the greater part of the controversy aroused by miners' nystagmus. These muscles are in physiological structures absolutely the same as the other muscular tissue of the body. Muscle spindles, or/

or structure closely resembling them, have been found by D. F. Buzzard in the ocular muscles which are innervated by the 3rd, 4th and 6th cranial nerves and supply a sensory branch of the 5th. The part played by the ocular muscles in the pathology of miners' nystagmus is expounded by Snell in the following resumé of his view:- "The nystagmus of miners is a myopathy, dependent on the peculiar position assumed by a certain class of men in the mine. With few exceptions the miners have been those whose work has been done on their sides as 'holers' . . .

"It is, I believe, a myopathic disease, a local affection and as a result of the prolonged strain in an unusual and constrained position, often prolonged and frequently recurring periods, . . . Chronic fatigue in the ocular muscles is brought about and, atony being produced, oscillation of the globes is caused. This kind of nystagmus is another instance of muscular disability induced by overwork. Its pathology is similar in this respect to the writers', pianists', and other forms of professional neurosis."

This is the view also taken by Dransart. "The myopathy will have its principal seat in the superior rectus and inferior oblique muscles; it occasions merely a weakness in the organs. The pair of elevators, having an acquired weakness, cannot overcome its antagonist by a single effort; it is obliged to attempt it several times by means of a series of little successive and rapid contractions. It then produces nystagmus,/

nystagmus, or rather gives occasion to, the vertical oscillation. To explain the horizontal oscillations which are noted in miners' nystagmus, we have recourse to the paresis of the internal recti and accommodation. The importance of the internal recti can suffice to explain the horizontal oscillations; they are produced by the same mechanism as the vertical ones. But the accommodation contributes to increase the muscular disorder by virtue of the relations which exist between convergence and accommodation, in other words, between the ciliary muscle and the internal rectus."

Snell's position depends on the following points:-

(a) The strain on the elevation (oblique) of the eyeball.

(b) The position of the miner, and

(c) The consequent weakness of the elevators.

I could not accept the view that fatigue of the elevators, due to constrained position, was the main factor in the causation of nystagmus amongst my patients, as the seams are mostly 6 feet high with a couple of 3 feet house-coal seams, and any undercutting is done by means of coal cutters; besides, other underground workers get nystagmus, such as hauliers (case 18); ostlers (case 23) and colliery boys (case 8).

Another factor that made me sceptical was the rotatory character of the movements even in those slight cases in which they can be elicited only on turning the eyes upwards. If due to elevator weakness, one would surely expect a downward, succeeded by a correcting upward twitch. What does take place is/

is a rhythmical rotatory movement. In some cases, indeed, in which the movements are evident only on gazing upwards, they are mainly from side to side, thus proving rhythmetical contraction of at least the external and internal recti.

Case 55: R. S. Age 45. Timberman certified 8/3/20. Conscious of movements six months ago after influenza. On asking him to stoop and then look upwards, lateral nystagmus was seen. He says he can steady his eyes by staring at an object on the wall after a while. He proved it, but says he is still conscious of movement when eyes become steady. After 5 months' rest from work he returned underground 17/8/20 with no further complaint.

N.B. This case shows not only side to side movement on looking upwards, but also that a sustained effort steadies the eye. How could a sustained effort suddenly steady a fatigued muscle?

The next case is another interesting one.

Case 60: D. J. Age 41. Collier for 28 years. Certified on 30/3/25. Conscious of movement for some time. Had acute gastritis 4 months back. Rotatory oscillation on looking upwards. I met this man coming out of a picture house one night and stopped to talk to him. He described how he got on inside. As soon as he got in, his eyes were very bad, and after a while things improved. As soon as he fixes his eyes on the picture, he cannot see anything, but if he fixes long enough, everything becomes clearer and he can see what is going on all right. If he/

he takes his eyes off the picture and immediately looks at the picture again, his eyes become bad again, only to clear after a while.

When I first saw him, his eyes were oscillating badly. He said that after going to the pictures his eyes would be bad till he had some sleep. This case shows:-

1. Oscillation made worse on going from a lighted into a darkened room.
2. After a while dark adaptation seems to check the movements.
3. Central fixation is not lost, as he can see what is going on in the pictures perfectly.
4. Sustained effort can stop the oscillation.
5. Oscillation is much more easily brought out in doubtful cases by keeping the patient in a dark room for a while before examination.
6. Picture houses are bad for these cases, as the man showed marked oscillation after a couple of hours inside.

The fact that the same form of nystagmus is not always found in the two eyes renders the explanation of nystagmus on the position-fatigue theory impossible. Thus Neiden found in 4 cases pure horizontal in one eye and vertical in the other; in 16 cases horizontal in one eye and rotatory in the other.

Another point against the myopathic theory is the fact that nystagmus may occur in positions other than those of the upward gaze. In some cases it was most marked on looking to one side, i.e., using only the external and internal recti; and in others on looking downwards the nystagmus continues. If in these cases fatigue/

fatigue is the prime cause, then a general fatigue of six or seven muscles must be postulated, and how the postion of the body, be it ever so fantastic, can bring this about, I quite fail to see.

Fatigue of the elevators has never been demonstrated, and tracings taken with the nystagmograph of Buys show that oscillations of miners' nystagmus are undulatory in character, and with the rapidity and extent of the oscillation increased by exertion, by diminution of light, and by looking upwards. Snell's main argument for fatigue of the elevators is based on the fact that in many latent cases of nystagmus, it may be at once elicited by directing the gaze upwards. This can be explained by the fact that upward vision is the least developed in man, hence it is the most difficult in which to retain the eyes in their proper relationship the one to the other, and the easy position in which the reflex movement can be set up in light by the subcutical discharge. Thus Maddox wrote: "In the upward gaze, when looking at infinity, there is a tendency to divergence." Again, no evidence has been brought forward to prove that the eyes are incapable of such an extensive upward movement as those of a normal individual. Moreover, Huckling Jackson speaks of the complete excursion of the globes.

3. <u>The source of the Innervation of the Ocular Muscles</u>.

The movements of the ocular muscles are regulated by nervous centres of different rank (vide Fuchs). The lowest centres are the/

the nuclei in the central grey matter which adjoins the ventricles, and from which the trunks of the nerves themselves arise. The nuclei lie one beneath the other and are connected by transverse fibres which run from the nuclei of one side to those of the other and by longitudinal fibres which join the proximal to the distal nuclei. From the nuclei, fibres extend to and from the centres for the voluntary associated movements of the eyes. The angular gyrus is believed to be the centre for reflex or involuntary associated movements, the centre for willed movements of the eyes being situated further forward in the cortex.

It has been found that in the floor of the fourth ventricle, the nuclei of origin of those muscles which act synargetically are in juxtaposition: the nuclei for the pupil, for accommodation and for convergence (internal recti); the nuclei of the superior rectus and inferior oblique (subserving elevation of the eye); and the nuclei of the inferior rectus and trochlearis (subserving depression of the eye).

In cases of gross nervous diseases, nystagmus only occurs in diseases of the mid-brain, corpora quadrigemina, pons or cerebellum, and it has never been recorded as occurring in disease of the nuclei of the cranial nerves or of the cerebral cortex (except when disease of the cerebral hemisphere caused pressure on the mid-brain).

These facts lead to the assumption of a centre in the mid-brain which controls what may be termed the "equilibration of the eyeball" which must be in close association with the centres for/

for the maintenance of the equilibrium of the body, and that disease which modifies their connection with this centre leaves the nuclear centres in an unstable state of equilibrium ready to respond to external stimulation by way of reflex action.

This centre or "a" centre, was first assumed by Will-Brand who explained nystagmus as a derangement of the general reflex centre or the volitional impulse of the eyeballs. He wrote:

"As the contraction of any muscle in the body disturbs the body equilibrium and stimulates the centres to an antagonistic movement - - - so with the eye."

Sir W. R. Gowers takes exception to this in that the perfection of muscular action depends on the synchronous contraction and relaxation of opposing or antagonistic muscles, whereas in nystagmus the contraction of its antagonists is in the recurring sequence.

He develops a theory of causation of nystagmus, basing it on the researches of Professor Sherrington. The latter found that in animals, if the spinal cord is divided in the cervical region so as to cut off the voluntary impulse from the brain to the lumbar centres, these pass into a peculiar functional state. When contraction in a group of muscles, say the extensor of the knee, moves the leg, their action ceases suddenly and the contraction of their opponents occurs, to cease in its turn when the extensors again contract. Thus there/

there develops an alternate contraction of the two sets which goes on automatically. If the nerve to the opponents be divided and the proximal end is stimulated, the effect is at once to inhibit the centre for the acting muscles. Since the nerve is purely muscular, the inhibition must be due to an impulse from the opponents caused by their extension, doubtless through the agency of the muscle spindles, and it also causes their own contraction. This process goes on alternately by a muscle reflex action.

Symptoms of the same nature may be occasionally observed in cases of lateral sclerosis in man.

These facts Gowers has applied in his theory of the mechanism of nystagmus. He assumes this mid-brain centre (mid-brain for reasons related previously) with its action of controlling and co-ordinating the complex action of the ocular muscles together with their reflex muscular action. When this centre is disturbed by various lesions, the control of the muscle reflex diminishes or disappears, and under the influence of extrinsic stimuli the alternate contraction and relaxation tends to be set in motion.

This briefly is Sir W. R. Gowers' theory of nystagmus, and the only objection that can be taken to it is that a rapidity of 360 oscillations to the minute does not allow much time for complicated nerve reactions.

Accepting the theory as a working hypothesis, examination may be made of the varieties of stimuli which may affect the centre,/

centre, with the idea of applying the theory to the explanation of the different clinical causes of nystagmus.

1. Congenital and Infantile Causes:

In all these causes the lesion is in the nature of an optical defect coming into play before the ocular centres have got into "working order". The light reflex must be through the same centres as the muscles concerned, and if this is absent as in the case of blindness, or imperfect as in the case of albinis, the functional or even the pathological suppression of the equilibration centre is easily conceivable.

2. Gross Pathological Causes:

It has been noted in cases of nystagmus occurring in cases of cerebral disease that the lesion, abscess, tumour, softening, etc., is always in or near, or affecting the mid-brain. It (the lesion) is not found in the cerebral cortex, where the volitional impulse may be supposed to arise, or in the subventricular centres where the muscular action is ultimately originated, and the nystagmus is explained by the distinction of the equilibration centre or of the fibres connecting it to the mid-brain.

3. Labrinthine Causes:

As before stated much work has been recently done on the connection between the semicircular canals with both the general equilibrium of the body and the movements of the eyes. It is an undoubted fact that nystagmus can be produced by irritating the vertibular apparatus. Schwartze states that he could at any time produce disturbance of the equilibrium and marked nystagmus/

nystagmus by probing a fistula of the semicircular canal.

It is also a well-known fact that the equilibrium of the eyes is very closely related with the equilibration of the body; this may be demonstrated by two converses:

1. The equilibration of the body is controlled to a great extent, by afferent impulses from the eyes, and for this reason Romberg's test in tubes is performed with the eyes shut.

2. When the equilibration of the body is disturbed, that of the eyes is apt to be disturbed also, and not in a haphazard way.

In this connection, I may cite the experiments of Cynon and Lee on the semicircular canals of fishes which established not only the equilibrating functions of these canals, but also the remarkable connection between them and the equilibration of the globes (vide Schwartze).

Peters has evolved a theory that miners' nystagmus is of autogenous origin, but his work contains and is based on a fallacy. He admits that he has no experience of miners' nystagmus, but has heard that an incipient attack may be warded off by holding the head backwards; he gives no authority for this statement, which is contrary to my experience and receives no support from any other writers.

However, he builds his theory as follows:-

A redistribution of the endolymph in the vestibule is produced by gravitation when the head is bent backwards as a compensatory movement to certain upward movements of the eyeballs, which it is not to be denied(?) produces at the same time/

time overstrain of the elevators. According to analogy with numerous experiments on man and animals, this position results in a passing movement of the eye downwards . . . But if this marked backward inclination of the head is maintained for months and years for eight or more hours a day, a new condition of equilibrium will be brought about to a certain degree, in which the backward bent head and upward turned eyes will have adjusted themselves with the position of the rest of the body, which is more or less vertical.

If now, with the return from work, the position of the head and eyes is changed to the upright, an irritation in the vestibule will be caused by the change in equilibrium, which may be manifested in a reflex manner from the central apparatus to the eye muscles. At first this condition will remain latent, and in order to make it manifest an additional irritation in the form of increased innervation to produce action of the elevators is necessary.

In his eagerness to prove his theory, Peters supports the theories of Eweld and Ach, that the muscular tone is in some manner or other dependent on the labrynth.

There seems to be no difficulty in agreeing with Peters that certain stimulation of the semicircular canals have an action on the equilibration centre for the body as a whole, and also for the eyes, producing in one case inco-ordination of muscular action and in the other nystagmus. I have succeeded in daylight to produce rotatory nystagmus in latent cases by producing/

producing a disturbance of the equilibrium of the body by rotation round a vertical axis, when the upward glance after bending down failed to elicit same. The men were told to close their eyes, and were rotated round a vertical axis till slight giddiness was produced, and then immediately on opening the eyelids, they were to fix the test card on the wall both at the level and then again below the level of the eyes, and in both cases fine rotatory nystagmus was produced when other methods failed. The true rotatory character of the nystagmus thus produced is certainly not merely compensatory, as in the turn-table experiment, nor can such a test throw any strain on the elevators, but they tend, however, to disturb the bodily equilibrium. I have performed this test with uniform success in many of these cases. This disturbance of bodily equilibrium, causing disturbance of globe equilibrium, may be the explanation of the reason why men put on surface work after a rest complain of inability to follow any employment on the surface which necessitates a disturbance of bodily equilibration, such as loading and unloading timber and material from railway trucks, etc.

4. Toxic Causes of Nystagmus.

The conception that an anaesthetic may remove the control of the eye equilibration centre over the lower centres and permit nystagmus to occur is not difficult in acute toxic cases; whilst the cases of nystagmus due to a chronic poisoning, such as that of lead, alcohol, ergot and arsenic, are all explicable by the theory that gross, even if minute, nervous degeneration is/

is caused by them in the region of the mid-brain centre.

There appears to be one outstanding basic factor largely responsible for the genesis of nystagmus, and that is toxaemia, due to mine gases acting through the circulation upon a central synapse which may be in the mid-brain or cerebellum, and followed by a syndrome of symptoms (Robson).

5. Occupational Causes, or Acquired Nystagmus:

The most widely accepted theories as to causation of miners' nystagmus, ascribing them to their most prominent British supporters, may be briefly recapitulated:-

(a) Snell's Theory - The myopathic theory.

The nystagmus of miners is a myopathy due to the peculiar position assumed by a certain class of men in the mines, i.e. "Holer".

(b) Jeaffreson's Theory - Cerebral anaemia (advanced in Durham where the men sit on their haunches to hew coal).

"The cramped position on the haunches produces a cerebral anaemia, chiefly of the parts which derive their supply from the basilar arteries, i.e. the occipital lobes; this is caused by the pressure on the tentorial ring, when the head is thrown far back on the upper part of the pons. The cramped position leads to a 'dissociation of naturally associated centres'."

(c) Oglesly's Theory.

Depending on venous engorgement of the medulla.

(d) Court's Theory.

Poor illumination is the greatest cause . . . if not the only/

only factor in the production of miners' nystagmus.

(e) Bell Taylor's Theory.

Miners' nystagmus is an occupational neurosis, strictly analogous to writers' cramp.

(f) Peters' Theory.

Nystagmus is caused by efferent impulse from the semi-circular canals whose functions have been modified by the position of the miner at his work.

(g) Reid's Theory.

This theory is an extension of Gowers' theory of nystagmus. Accepting the existence of an eye equilibration centre, he assumes that it is affected in a functional manner which is in the direction of suspension of its function by:-

1. Poor illumination, abolishing the superior macular image.
2. The constant tendency to disturb the equilibrium of the body entailed by the necessary swinging of the arms with the pick, with the jar at the end of the stroke.

The occurrence of a few cases of nystagmus in occupations other than coal mining must be considered in the light of facts that (a) in normal persons nystagmus is found occasionally; (b) in debilitated states nystagmus twitching is occasionally observed; and (c) nystagmus has been in hysteria. Careful examination of Snell's recorded cases points to the fact that the majority of them were cases of asthenopia and not nystagmus.

present, the spot of light will be seen to quiver.

(2) Reid's rotation test consisting of spinning the patient round and round is unreliable, as nystagmus is produced in normal people in this manner caused by the movement of endolymph fluid in the semicircular canals.

(3) Persistence in raising his head and not his eyes in being asked to look up is a peculiar feature in patients suffering from miners' nystagmus. In such cases the presumption that the disease is present is usually borne out by the detection of movement of the eyeballs. To examine such a case it is necessary to keep the head flexed with one hand, while the other holds the pencil, and the test continued as before. If head tremors are present the hand on the head will feel their presence, while at the same time if flexion of the head be continued a feeling of resistance will also be felt.

Head tremors are also seen in neurasthenics and in old age, but they are generally of a coarser nature, and increase in intensity for some time. Head tremors in nystagmic patients continue for some time after the disappearance of the eye movements.

The true movement of the eyes in miners' nystagmus is a rotatory one- ("the rotatory movements are seldom, if ever, absent", SNELL)- and both eyes are equally affected, but it may be present one day and not the next, but many patients who suffer from the disease can produce the oscillations at will by stooping or shaking their heads.

A complete examination should be made, especially in those cases/

cases which show purely lateral movement and unequal on both sides.

Differential Diagnosis.

Nystagmus may be congenital or acquired.

Congenital Forms.

A.
Diseases of the choroid and retina, as retiniti pigmentosa, congenital cataract and corneal nebulae.

B.
Complete albino always has nystagmus.

C.
Sometimes found in errors of refraction.

Children born with very high refractive errors may also be subjects of nystagmus (Norman B.M.J. 1912). In these cases the eyeballs show a wandering unsteady movement as a result of non-development of steady fixation owing to high error of refraction.

High degree of myopia in miners may give rise to difficulty in diagnosis. Here, we usually find a coarse unsteadiness of the eyeballs, and not the fine rhythmical rotatory movements. In such cases, lidspasm, headtremors may help.

Acquired Forms.

A.
Miners' Nystagmus. Found only in Workers of the Coal mines.

B.
Gross Pathological Causes in the Central Nervous System.

(1) Cerebral disease, lesions-abscess, tumours or softening occurring in, near, or affecting the midbrain. For example:- Cerebellar abscess. Here the nystagmus is lateral more marked on one/

one side - the side of the lesion - and unequal, it may be present at one time and abscent at another. Its direction may be to the side of the lesion, or to opposite side, or to both. Nystagmus increases as the abscess progresses.

(2) A group of nervous diseases may give rise to the symptom of nystagmus, notably amongst which are Disseminated Sclerosis and Syringo-myelia. Here again the movement is generally lateral and unequal on both sides. In Disseminated Sclerosis there is a typical quick jerk and slow return, which is not obtained in miners' nystagmus even if the movements in the latter appear to be lateral. Above all a general examination will settle all doubts.

C. Toxic Causes.

The nystagmus resulting from chronic poisoning such as that of lead, alcohol, ergot and arsenic ought to give no trouble in diagnosis. A transient nystagmus is sometime seen in acute poisoning by carbon monoxide and chloroform.

D. Pathological conditions of the labrynth may give rise to nystagmus.

Irritation of the labrynth such as in cases of erosion of the bony capsule of the external semilunar canal give rise to a transitory nystagmus on sudden movements of the head. A mixed horizontal and rotatory nystagmus is seen in cases of destructive lesion of the labrynth. Here the nystagmus is directed to the opposite side of the lesion - to the normal ear. Another characteristic of this nystagmus is its early disappearance in these/

these cases.

Vestibular nystagmus consists of two phases, namely, a slow conjugate deviation of the eyes in one direction, followed by a rapid jerk to the original position.

E. Barany of Vienna in the year 1907 published that nystagmus may be present after rotation of a person about his own axis to the right at a rate of 10 turns in 20 seconds and then stopped. It can also be produced by syringing the ear with hot or cold water, by galvanism to the head, and by alteration of air pressure-compression and aspiration by a Politzer bag through the external auditory meatus. These tests of Barany are now used in the routine examination of the ear in cases where the vestibular apparatus is believed to be affected.

F. Voluntary nystagmus has been described by various writers - Nettleship, Mauersberg and Stirling. The most notable case is that of a house surgeon, who by strong converging his eyes, produces lateral nystagmus.

The diagnosis of miners' nystagmus rarely present much difficulty. In cases where nystagmus was not disclosed at repeated examinations after prolonged stay in the dark room, then one has to rely on the history, general appearance of the patient, photophobia, head tremors, head resistance and lid-spasms. Lid-spsam or nictition of the eyelids is a true clonic spasm, and it continues when the man thinks himself free from observation. The presence of nictition of the eyelids may sometimes give rise to difficulty in the detection/

detection of nystagmus.

It is important to remember that lidspasm may be produced by instillation of tobacco juice into the eyes; and not infrequently caused by foreign particles under the lids.

PROGNOSIS

No man loses his sight from Nystagmus.

Unfortunately there is an idea abroad that these patients must never go down the pit again unless they wish to become blind. This is not the case as a cure is only a question of time, but to pass a sentence of industrial death upon a nystagmic miner is greatly to be deplored.

Generally speaking one may say that all signs and symptoms ought to disappear after the patient has been out of his pit work for two years, and in cases in which recovery is long delayed there is always some cause for it, which ought to be thoroughly investigated and alleviated whenever possible.

In the prognosis, the following points may be mentioned:-

1. Age - the younger the patient, the quicker is the recovery. This is borne out by my 17 young cases which have an average period of incapacity of only $7\frac{1}{2}$ months. Recurrence is seen in the young as well as in the old, but even with repeated breakdowns in the young, ultimate alleviation does take place and there is no necessity for them to leave pit life except perhaps in those cases where the family nervous history is not good. (Cases 2 & 3)

2. Rapid onset is followed by early convalescence and conversely. This is best seen in young cases in which acute onset is usual, that is, they have never had any suspicion of their eyes being in any way afflicted before then. This is seen in the following cases:-

Case 89. W.H.M. Age 36. Labourer. Foreign body in eye

on/

on 3/1/22. Removed cocaine. Week out. On 19/1/22 everything moves when working and not conscious of movements before. Photophobia and headache. Certified rested for two months and then returned underground to his work without any further complaint.

Case 102. R.M. Age 50. Had attack of acute conjunctivitis with sleeplessness. Eye sight good V.6/6 not conscious of movement except for a week beforehand. Suddenly became worse, eyes watery and injected, photophobia. Had a month's rest and returned to underground work. Incapacity 25/3/19 to 29/4/19.

Case 143. W.P. Age 50. Collier. Conscious of oscillation for some 2 years. Had acute lobar pneumonia January 1923. Returned to work about a month later. Had to give up working on 14/6/23 as the roof seems to come down on him, when he has to go and sit down and send a boy to see whether any portion has fallen down. After 15 months rest he was put on the surface on 8/9/24.

3. Alcoholic patients are bad cases (Cases 28.37.36.33) The sooner these people do surface work the better. With the exception of Case 33, the other three have been commuted by the Company.

4. Those cases in which there is the added complication of general system these diseases are unfavourable.

Case 78. E.W. Age 59. Collier 48 years. Aware of oscillation for some years. Incapacity after acute bronchitis three months previously. Certified on 15/7/21. Marked rotatory oscillation with photophobia, lachromation and Blepharospasm. Oscillation seen looking in all directions. A chronic asthmatic with failing circulation. Have not done anything since.

Case 59. J.T. Age 45. Collier. Had acute rheumatic fever 1919/

1919 leaving him with mitral disease. He returned to work in six months. A little shortwinded, but able to carry on with his son. Conscious of movement for twelve months or more, but unable to carry on because of his eyes. Certified 11/9/20 with rotatory oscillation and Blepharospasm. Has not worked since, sensible man, rested as much as he could. Apart from nystagmus which is still present he is physically unfit. His nystagmus progressively improved. This means that incapacity results from his heart condition much more than his eyes.

5. Marked errors of refraction are a deterrent to complete recovery (case 26) and that correction of refraction errors ought to be insisted upon.

Working Capacity and economic considerations.

Oscillation of the eye does not necessarily cause incapacity. For instance, the congenital forms of nystagmus (often hereditary) rarely cause any incapacity, unless they are accompanied by other disabilities, such as cataract or albinism. Children so affected usually do well at school, and as adults even in the various professions, they do not experience incapacity and are quite unconscious of the movements of their eyes.

Coal miners are often quite unaware of their eye condition, until their attention is drawn to it by other people, as when they are attending a hospital or institution for some other condition. In view of the factthat 20 to 40 % of all underground workers in coal mines have oscillation of the eyeball, the drawing of their attention to the condition is to be deprecated.

The incapacity produced by the disease does not entirely depend on the severity of the physical signs present. One man may have violent nystagmus and little incapacity, while another may have marked incapacity and little movements of the eye. That oscillation does not always produce incapacity is typically seen in this man.

G. C. Age 52. Collier. Marked rotatory oscillation of the eyeball, even when looking straight forward. Conscious of movement for six years but no incapacity whatsoever. He gets certified as suffering from nystagmus whenever there is a lockout, so as to make the management responsible and he receives a penny

a/

a week. The idea is to ensure getting back his work when the dispute is over. I asked why he is never incapacitated and he replied with the following words, "That lamp boy has learned to look after my lamp. Whenever it is badly charged, the air will be blue".

Many men can work on the surface without any period of rest and in these cases the attack is usually mild and the prognosis is favourable. In my list of cases, 13 were placed on the surface direct, and 11 within a month of certification. This early placement of cases on the surface for work is especially beneficial for the afflicted young miner, as without anything to do and all day to do it in, they may get into bad company and lead to alcoholism. On the whole it may be said that the sooner a man gets surface work the quicker and better are his chances of recovery. If unable to obtain work on the surface, then they should be encouraged to do little jobs out of doors in the garden, as woodchopping etc.,

Ordinary cases take about 12 months to recover and severe cases very slowly and incompletely especially in those cases in which the physical element is marked.

This is seen in Case 21. This man has had an incapacity of nine years, and recovery took place eventually. Healthy in body, but was neurotic. Oscillation and neurosis completely disappeared. He was refused his usual work underground because of fear of recurrence. What is his redress? The only course open to him, to my mind, is to sue the management for his usual work/

work, or, in lieu, compensation. I think it will be up to the management to prove that, in the event of any recurrence, it will be the result of some constitutional predisposition on the part of the man to this disease and not to any increased susceptibility to nystagmus in consequence of the first attack.

Personally I do not think that constitutional disturbance has anything to do with his case, as he is a healthy man, and had worked in the pit for nearly 30 years before he developed his attack.

I have attempted to analyse the incapacity of my cases, which were certified between the years of 1919 and 1925, showing the position at the time of the general strike, May 1926. The results are as follows:-

Number of Cases 185. (Six are old recurring cases and are counted as fresh cases)

Of these.

(a) 139. Cases resumed work either below ground or on the surface.

(b) 38. Cases totally incapacitated from first certification.

(c) 8. Died during incapacity from concurrent diseases.

Of the 139 Cases in Group (a):-

13 were put on the surface direct from underground and have had no rest.

126 had an average 12 months rest before resumption.

Of the 126 cases who have been idle:-

91 were put on the surface.

33 went back to work underground.

1 became a farmer - not recovered.
1928 Now recovered.

1 became a milkman - recovered.

Of the 13 cases sent direct to the surface - no rest:-

All were still there at the time of the stoppage. These were only certified at the end of 1924 and were recent cases.

Of the 30 cases sent underground direct after rest without surface employment:-

Average Incapacity 9½ months.

Shortest Incapacity 1 month.

Longest Incapacity 25 months.

Certified free before return 2

15 had no further complaint.

10 given light employment underground.

7 had recurrences. The average period of rest of these cases was 8 months, but no surface employment before resumption. (6 colliers and 1 haulier).

1 certified free after resumption.

Of the 91 cases sent to the surface after period of idleness:-

Average period of rest before going on surface 8½ months.

71 still on the surface.

8 left colliery

1 Vaudeville Artist 1928 fully recovered

2 Unknown occupation 1928 " "

1 Labourer 1928 recovered

2 Insurance Agent 1928 recovered

2 To America

1 Recovered

1 No Nystagmus present

1 Certified free by Referee

1 Died

1 Failed to work on surface. Epilepsy Case 10 1928 Not recovered.

7 Returned underground.

5 of these are colliers and 2 hauliers.

2 of these 5 colliers had recurrence.

Recurrences total.

9. 8 colliers and 1 haulier.

Group B. 38 Total Incapacity up to May 1926. Their time of first certification.

1919	1920	1921	1922	1923	1924	1925
1	1	0	3	6	11	16

Studying these figures, one is struck by the large number of cases being placed on the surface, and so the statement that the colliery management would rather pay full compensation than find surface work for the men does not apply to the pits here, as 50% of the total cases have been placed. It certainly does not pay the management to do so, for many of these men are receiving the current surface wage plus as much as a £1 weekly difference, and at the same time the management has to be satisfied with a C3 personnel on the surface. There is no doubt that to keep improving cases idle is bad from the workman's point/

point of view, as he will gradually drift into a condition of helplessness which will prolong his incapacity; but on the other hand there is little encouragement for the management owing to the slow return to work underground, as in these pits, the number who remained on the surface, according to my figures, is 71 out of 91 placed during the few years. This slow return to pit-work rate has given rise to the suggestion that compensation should cease after a certain period, and is steadily gaining ground. Such return is either voluntary, by mutual agreement, or by arbitration before a County Court judge, as the nomenclature of the disease in the W. C. A. determines the standard of incapacity. This, helped on by the fact that oscillation of the eyeball remains for some little time after the apparent movement of surrounding objects has disappeared, has an important influence on the duration of incapacity.

Nystagmus is a pre-eminently curable disease, cure is merely a question of time, but recurrences are seen and in this series of cases, nine have had recurrences, being equal to about 5% of the total. Eight of these recurring cases are seen in the collier class and only one haulier. I may say, I think, that the privilege of recurrences belong entirely to the colliers, as the only haulier had been a collier for some years.

It is interesting to note that in these nine recurring cases, seven of them went back to work direct without a period of surface employment, and only the remaining two have been placed on the surface/

surface before resumption underground. I have never seen a recurrence in a case which has been certified free from nystagmus before the medical referee.

I think I may say that recurrences are confined to colliers, that it usually occurs in those who have not had sufficient rest, and that it is not seen in those who have recovered from nystagmus.

With regard to Group B, the large number of cases of total incapacity remaining at the time of the general strike from the years 1924 and 1925 was the result of the closing down of one colliery employing 2,500 hands and so it was impossible to put them to work. It is interesting to note that six of these cases are down as recurring cases, and there is very little doubt that they would have carried on underground if their pits were working.

In order to bring the figures up to date I have further analysed those cases which were still incapacitated at the time of the general strike which ended in December 1926. The position of these cases at the present time (May 1928) is as follows:-

Out of 38 cases of total incapacity:-

Placed on surface work	23	:	Commuted	3
Still incapacitated	3	:	Certified free by Med. Referee	1
Returned underground	7	:	Change of occupation (Milkman)	1

Of the three commuted, one is a chronic alcoholic (Case 28), one qualifying for old age ($64\frac{1}{2}$) pension very soon and with chronic bronchitis, and the other wishes to leave the district with his family/

family for Australia.

The three cases of total incapacity are physically unfit. One with Parkinson's and a marked family history of nervous disease, one again 69, one with V.D.H..

Out of 13 sent direct to the surface without rest:-

Remained there	5.	Recovered and returned underground	5
Died	2.	Commuted	1

The position at present of the 71 still remaining on the surface in May 1926 is as follows:-

Still on the surface (Unemployed 28)	38 :	Recovered	13
Commuted	13 :	Died	3
Certified free	3 :	Failed on surface (Bright's Disease)	1.

The number of cases commuted is high owing to the fact that depression in the coal trade, lowering of wages and the doing away of 300 surface hands owing to reorganisation, have made many men look for pastures new, and a lump sum will help materially in furthering that desire. Nine of these cases are under 40 years of age and three are chronic alcoholics. The others are 60 and over.

To anyone studying these figures, I think I may say that miners' Nystagmus is a benign affliction.

TREATMENT.

A. Prophylactic.

The fact cannot be overlooked that illumination is the greatest factor in the production of the disease, and therefore every effort should be directed towards obtaining greatly superior illumination for coal-miners. With better illumination there would be associated, not merely freedom from nystagmus, but also better output and diminished liability to accidents. Therefore I would recommend a general adoption of the electric system, as it is extremely doubtful whether the oil lamps could be so improved as to give better illumination. It is true that the installation of electric lamps in some pits has not diminished the number of cases, but this does not mean that the venture has been a failure, as the disease is of gradual onset, and the benefit from increased illumination is not felt at once. It is true that men on the point of failure may be troubled with the brightness of an electric lamp than relieved by the increased illumination which it gives, and many of these men blame the electric lamps as the cause of their failure. On the other hand men on the point of failure or failed to work with an oil lamp, have returned to work with an electric lamp.

The care of the lamps is a very important matter. It is a wise policy to employ a trained electrician to look after them. Under the charge of an expert, lamps in a colliery will give a higher candle power than one not under the charge of a trained man./

man. On the other hand the men should be educated to take care of their lamps. As there is no danger of "losing the light", some men will take advantage of an electric lamp, as in using it as an emergency tool. This will strain the plates and terminals of the battery and so the life and light-giving properties of the lamp will be largely reduced.

The ideal lamp to my mind, (if the installation of the cap lamp is inadvisable) will be one with the following characteristics:-

1. It must be a safety lamp. That is, there must be no danger of its causing an explosion, even if broken. The danger of fusing in an electric lamp must be foreseen and provided against.
2. It should have as great an illuminating power as possible. Here, of course, economy will come into play, but I will aim at 4. C.P. at least.
3. It should be so constructed that the light does not play at the eyes of the miner who is using it. This may be obtained by the use of a revolving blind.
4. The use of a reflector will materially help to increase the C.P.
5. It must not be in the nature of a search-light, such as a bulls-eye, lantern, for general illumination is required, yet the production of a central beam would be an advantage.
6. Instead of the usual pillars and bonnet, a moveable bridle carrying a reflector should be substituted. This will abolish the shadows and give an all round light when the bridle is down, thus/

thus facilitating examinations of the roof.

The Cap Lamp recently introduced in some pits is highly recommended. The advantage of the cap lamp are such that its field is bound to extend very considerably.

1. It concentrates the light on to the work.

2. If the wearer turns, the light follows in that direction, so that the maximum illumination is always available.

3. Both hands are left free - a decided advantage.

4. There are no shadows, and the man's body cannot cut out the light.

5. The cap lamp is much nearer the working area, and its rays fall at right angles and not obliquely as in the case of a stationery lamp. As the illumination of a surface varies with the cosine of the angle of incidence of the light, and the intensity of illumination varies inversely with the square of the distance from the source of the light, the greater illumination given by the cap lamp is obvious. The difference of illumination given by an electric cap lamp and a stationery one is so marked that it must be seen to be fully appreciated. Such a lamp will give from 10 to 20 times more illumination on the working area than an oil or electric lamp.

7. The bulb will automatically be disconnected if the glass is broken.

These are not so satisfactory in deep and hot pits where the men work stripped to the waist, on account of the heat. Here they/

they complain of chaffing of the skin by the rubbing of the battery box held round the waist. The necessity of wearing a cap leads to discomfort. The lamp is excellent in the roadways, for examination of the roof, and for hauliers in all classes of pits.

Two batches of ten were introduced into a pit here and the chief complaint was by those who were not so fitted, as the light of the fitted ones working alongside of them shone in their eyes but with those who were similarly fitted, they experienced little trouble.

Many of the new lamps on the market today are fitted with tinted or posted glass to prevent glare. In the low illumination of a coal mine any direct rays of light which fall into the eye produces inconvenience, and in the case of the nystagmic worker, even pain may be produced. This leads to the fitting of yellow glasses to miners' lamps, and to the use of posted glass to combat the glare. This is appreciated by the men though it causes a certain amount of reduction of light.

Elworthy of Ebbu Vale has pointed out that the quality as well as the quantity of light must be considered. He put forward the theory that the incurable cases of nystagmus may be due to ultra-violet burns. Experimenting with light filters, he found that the light from an electric lamp contains twice as many blue rays as that from a candle or oil lamp, and that these blue rays have an exhausting and irritating effect on the eye. His analysis has been confirmed by the Miners' Nystagmus Committee, but his conclusions/

conclusions are negativated, after experimentation with aesculine screen and wratten filters. The committee stated that the illumination was reduced some 10 to 20 % by the use of these screens.

Aesculine Screen (to cut off all ultra-violet rays with little absorption of the rest of the spectrum) Wratten Filters (to bring light more in line with a candle).

Elworthy makes the remarkable proposition that the mines should be colour washed. This is an ideal proposition but it was considered useless in view of the size of the mine, the dust laden currents and the continually altering face. Nowadays it is customary to whitewash the main roads for some distance from the pit bottom, and stone dusting up to the coal face has become compulsorily introduced. This procedure has many advantages:-

1. Increased illumination in the roadways, so that the miner can proceed to and from his work without delay.

2. The discomfort following the sudden plunge into the darkness is done away with.

3. Great relief is gained by the miner by the toning down between the bright outside light and the darkness of the workings.

It has been suggested that the case incidence of nystagmus is increased by the men working down the mine in the day time, thus losing the advantage of daylight on their return from work, but there seems to be no foundation in fact as a large proportion of miners work on days and night in alternate weeks.

As to the ventilation of the mine, that is secured by the Coal/

Coal Mines Regulation Act.

The elimination of unfit workmen by examination of their sight is considered advisable by some writers. This is rather drastic and as refractive errors are now known to have no relation to nystagmus coupled with the fact that men with high refractive errors can work successfully underground, this is not necessary, but those men who have refractive errors ought to wear spectacles.

B. Curative Treatment.

Snell says that in most cases change of work is the only thing necessary. The general opinion has been that the man should leave the pit at once. Some go so far as to say that the man should not return to work underground after the attack.

In the early stages of the disease change of work from the coal face to other parts of the pit may ward off a threatened attack. If the symptoms continue, the man should leave the pit and obtain work on the surface.

The severe cases are unable to do anything and need complete rest.

Rest, and work out of the pit are the only specifics for miners' nystagmus, and medical treatment with the exception of the exhibition of tonics is of very little use.

In severe cases when the disease produces marked symptoms, the absolute removal of the patient from his work in the mine until the nystagmus has disappeared completely is essential. It is necessary to insist on this, although it may be regarded as a counsel of perfection, for one finds at the present time one has two opposing interests/

interests to contend with. In the first place the miner - if an honest man - is anxious to get down to the pit where he can earn more money, and is continually asking his medical adviser for permission before his physical signs have disappeared, although his symptoms may not be pressing; in the second place the mine owner objects to paying compensation longer than he is absolutely forced, and desires the man to return to work at the first opportunity possible. But in insisting on the cessation of work in the mine one does not disallow work in daylight, and, in fact it is my opinion that idleness forced on a man by the receipt of compensation militates against his early convalescence.

Some colliery managers have the idea that their actual cost of production must be kept low, and so they prefer to pay a man full compensation rather than find him light work on the surface (and preferably in the fresh air) and pay him a small wage and what he can legally claim - half the difference between what he earns in his normal earning capacity. There are two reasons for the refusal on the part of the management to do this: (1) the high average former weekly wage which often necessitates the payment of £1 a week in half difference in addition to the usual surface wage; (2) the ca'canny policy which some workmen pursue, as we will see from the return to pit work rate from the surface which is very low. It is my contention that surface employment plays as great a rôle in the treatment of the disease as work underground does in its production. The earlier the men are put on surface work, the quicker and better are his chances of complete and ultimate recovery. If the/

the management is unable to give surface work to convalescent cases the men should be allowed to get work outside the colliery of any description they can find without forfeiting or diminuation of compensation for a period, say three to six months.

On return to work underground a light giving better illumination cap lamp - should be supplied.

After removing the patient from his faulty environment one proceeds to treat his general health with such tonics as quinine, strychnine, and hypophosphites etc., and at the same time see that strict temperance is observed in the use of alcohol. The visiting of clubs and public houses should be prohibited after 8.30 at night as going home late nightly indulged by some of these cases delay convalescence. This rule, formulated by a local sick fund a couple of years ago, was instrumental in making not a few declarations off the said fund.

Concurrent diseases must be thoroughly treated, otherwise prolonged incapacity results.

Should the nystagmus be accompanied by, or be the cause of nervous manifestations such as headache, giddiness, dizziness, photophobia or general tremors, they must be seen to and relieved. A course of sedatives - the bromides Luminal Gardinal Sodium may be tried followed by a course of tonics.

The correction of refractive errors is of great importance. Clark calls attention to the great loss of nervous energy which may result from a small error of refraction. He says that it is often the smallest error that causes the greatest eye strain. I have found/

found in many cases that when the nystagmic patient has had his error of refraction corrected a great relief in all the subjective symptoms is experienced, but little change is found for some time in the movement of the eye. Headache is relieved at once and the man's condition improves. The effect is sometimes magical.

For photophobia, Crooke's anti-glare glass may help, but dark glasses are useless as the men usually complain that they make them worse.

Drugs are useless in miners mystagmus. Formic Acid had been recommended by Percival in doses of 5 minims of a 25 per cent solution, but I find it of no service.

Instillation of atropine into the eyes has been tried without success.

Raimee advises the use of a 3% solution of eserin three times a day.

Electric stimulation has also been advised, and I find that application of the constant current to the temples relieved headache and sleeplessness in some cases.

Lately I have tried the action of Radiostol on these cases and find that though it has no effect on oscillation, it does some good in improving appetite, general health and mental outlook in these cases, especially during the dark winter months when sunlight is at a minimum. This is a preparation in pellet form made by the action of ultra - violet light upon ergosterol.

SUMMARY.

Etiology.

There have been two chief views with regard to the causation of the disease (1). That it is due to the position assumed by the workers necessitating an upward direction of visual regard and a cramped attitude of the body. (2). That it is due to the strain of working in deficient light. The arguments for and against these respective views are as follows:-

(1) Position Theory.

For:

Nystagmus is often only brought out when the eyes are directed upwards.

The men who 'hole' much, and who have consequently to direct their eyes obliquely upwards, are the men chiefly affected by the diseases.

Firemen, who have to direct their eyes upwards to examine the roof, are often affected.

Against.

Holing in naked light pits does not produce nystagmus.

Upward direction of visual regard is not necessary or usual in holing.

Where no holing is done nystagmus is rife.

Those whose work do not necessitate the upward glance, suffer from the disease.

It is the movement of the eyes, and not the muscles of elevation/

elevation that are affected.

A sustained effort steadies the movement in some cases.

(2) Deficiency Theory.

The disease was unknown prior to the introduction of the safety lamp.

With improvement of illumination the incidence of the disease diminishes.

The disease is practically unknown in naked light pits.

In America the disease is unknown as naked lights have given place to electric cap lamps.

The experimental evidence supplied by Ohm may be said to be conclusive with regard to the relationship of nystagmic genesis to deficient light.

The skilled workman - the men who have used their eyes the most - are more often affected than men from other grades.

Conditions determining the occurrence of the disease.

Occupation:-

The men who work at the coal face are chiefly affected, but no class of underground worker is exempted.

Age:-

All ages are attacked, but the longer a man works in the pit the more he is likely to contract nystagmus. The greatest number of cases are seen between the ages of 40 and 50, representing 34% of my cases. The mean age at onset is 41 years and the mean period of underground life before the onset of symptoms is 29.3 years/

years.

Method of Work:-

Holing alone has no influences on the production of the disease except when done in deficient light. No holing is done in this district but nystagmus is rife.

The Personal Factor:-

Men working under precisely the same conditions are attacked unequally; some will contract the disease and others escape. Men have worked over 50 years underground without showing any signs of nystagmus, and yet a case may develop the disease within a year. This may be a determining factor in the disease.

Error of refraction has no relationship to the incidence of miners' nystagmus.

Accidents and illnesses have nothing to do with the etiology of the disease as primary factors, but they have everything to do with the conversion of latent into manifest cases. About 50% of my cases date their attack from such injuries and illnesses.

Hereditary defects may accelerate the development of nystagmus in those so afflicted, and it may even prevent ultimate complete recovery.

Alcoholism is not a causal factor in the incidence of the disease. Over indulgence may convert latent cases into the manifest.

Diagnosis:-

It is made by the presence of rotatory oscillation of the eyeballs, and the movement is most easily brought out by asking the/

the patient to elevate his eyes, by diminishing the light and by exertion.

Prognosis.

This depends on a number of factors.

The younger the patient the quicker the recovery.

There is no age limit to complete recovery.

Marked errors of refraction, concurrent diseases, alcoholism, marked neurosis are deterrents to complete recovery.

There are varying degrees of gravity of signs and symptoms and varying periods of time of recovery for same: i.e. in different patients. Slight cases recover quickly, ordinary cases in about 12 months, severe cases slowly.

Oscillation of the eye does not necessarily cause incapacity.

Relapses should not be taken as a bar against underground work in the future.

Recurrences are confined to the colliers.

Surface employment plays as great a role in the treatment of the disease as underground work does in its production. The earlier the men are put on the surface the quicker and better are their chances of recovery.

CONCLUSIONS

1. Miners' nystagmus is an occupational disease of the nervous system, occuring in two forms, confined to workers in coal mines. The chief physical sign is a rotatory oscillation of the eyeballs giving rise to apparent movement of objects as its prime symptom.

2. The disease, generally of gradual onset, though acute cases are seen, especially in the young, attacks men of all ages, but is most commonly seen in middle life.

3. Deficient light is the chief etiological factor, other factors such as method of work, accidents, errors of refraction, alcoholism and general diseases, are of secondary importance only.

4. As to prognosis, there is no truth in the statement that miners' nystagmus causes permanent damage to the eye, or even blindness, if underground work is continued after the onset of symptoms.

5. The disease may be said to be a benign one as it is pre-eminently curable.

6. The ideal preventative measure would be to instal electric lighting at the coal face but as the men will not have electricity either for lighting or for machinery in view of the prevalence of gas, the obligatory stone dusting and the adoption of white washing coupled with a change of lamps to the cap pattern, will, I believe, help, if not to wipe out nystagmus, at least/

least to render it sufficiently mild so that incapacity resulting from it will be largely prevented.

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